NEW ENGLAND WATER WORKS ASSOCIATION.

ORGANIZED 1882.

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This Association, as a Body, is not responsible for the statements or opinions of any of its members.

QUARTERLY MEETING.

YOUNG'S HOTEL, BOSTON, MASS., DECEMBER 14TH, 1892.

The following members and guests were present:

ACTIVE MEMBERS.

Everett L. Abbott, Civil Engineer, New York city; Solon M. Allis, Malden, Mass.; Charles H. Baldwin, Boston, Mass.; Lewis M. Bancroft, Chairman Water Commissioners, Reading, Mass.; George E. Batchelder, Registrar, Worcester, Mass.; Joseph E. Beals, Supt., Middleboro, Mass.; William R. Billings, Taunton, Mass.; George H. Bishop, Civil Engineer, Middletown, Conn.; George Bowers, City Engineer, Lowell, Mass.; Dexter Brackett, Asst. Engineer, Boston, Mass.; George F. Chace, Taunton, Mass.; Charles E. Chandler, City Engineer, Norwich, Conn.; William F. Codd, Supt., Nantucket, Mass.; Freeman C. Coffin, Boston, Mass.; R. C. P. Coggeshall, Supt., New Bedford, Mass.; Byron I. Cook, Supt., Woonsocket, R. I.; Henry A. Cook, Supt., Salem, Mass.; F. H. Crandall, Supt., Burlington, Vt.; Lucas Cushing, Asst. Supt., Boston, Mass.; Horace L. Eaton, City Engineer, Somerville, Mass.; B. R. Felton, City Engineer, Marlboro, Mass.; F. F. Forbes, Supt., Brookline, Mass.; Z. R. Forbes, Asst. Supt., Brookline, Mass.; Frank L. Fuller, Civil Engineer, Boston, Mass.; L. L. Gerry, City Engineer, Dover, N. H.; W. J. Goldthwait, Marblehead, Mass.; J. A. Gould, Jr., Asst. Engineer, Boston, Mass.; Frank E. Hall, Supt., Quincy, Mass.; John Harris, Commissioner, Waltham, Mass.; John C. Haskell, Lynn, Mass.; Allen Hazen, Chemist, Lawrence, Mass.; Horace G. Holden, Supt., Nashua, N. H.; J. C.

Howe, Jr., Haverhill, Mass.; Patrick Kieron, Supt., Fall River, Mass.; George A. Kimball, Civil Engineer, Boston, Mass.; Wilbur F. Learned, Asst. Engineer, Watertown, Mass.; W. E. McClintock, Civil Engineer, Boston, Mass.; William McNally, Registrar, Marlboro, Mass.; Hiram Nevons, Supt., Cambridge, Mass.; Edward H. Phipps, Supt., New Haven, Conn.; Charles E. Pierce, Supt., East Providence, R. I.; Waldo E. Rawson, Supt., Uxbridge, Mass.; Walter H. Richards, Supt., New London, Conn.; George J. Ries, Supt., Weymouth Centre, Mass.; Henry W. Rogers, Supt., Haverhill, Mass.; George O. Sanders, President, Hudson, N. H.; William T. Sedgewick, Professor Biology, Inst. of Technology, Boston, Mass.; William B. Sherman, Mechanical Engineer, Providence, R. I.; Solon F. Smith, Supt., Grafton, Mass.; Frederick P. Stearns, Chief Engineer State Board of Health, Boston, Mass.; Eugene S. Sullivan, Supt. Mystic Division Charlestown. Boston, Mass.; Lucian A. Taylor, Civil Engineer, Boston, Mass.; Joseph G. Tenney, Supt., Leominister, Mass.; Robert J. Thomas, Supt., Lowell, Mass.; William H. Thomas, Asst. Supt., Hingham, Mass.; D. N. Tower, Supt., Cohassett, Mass.; W. H. Vaughn, Supt., Wellesley Hills, Mass.; Charles K. Walker, Supt., Manchester, N. H.; Horace B. Winship, Civil Engineer, Norwich, Conn.; Frederic I. Winslow, Boston, Mass.; George E. Winslow, Supt., Waltham, Mass.; E. T. Wiswall, Commissioner, West Newton, Mass.

ASSOCIATE MEMBERS.

James M. Betton, H. R. Worthington, New York city; A. H. Broderick, Chadwick Lead Works, Boston, Mass.; E. L. Ross, Chapman Valve Co., Indian Orchard, Mass.; C. H. Eherle, Crosby Steam Gage and Valve Co., Boston, Mass.; F. H. Hayes, Deane Steam Pump Co., Holyoke, Mass.; Charles H. Eglee, Contractor, Flushing, N. Y.; Henry F. Jencks, Pawtucket, R. I.; F. E. Stevens, Secretary Peet Valve Co., Boston, Mass.; H. L. Bond, Perrin, Seaman's & Co., Boston, Mass.; W. H. Van Winkle, Anthony P. Smith, Newark, N. J.; I. W. Dodge, Standard Thermometer Co., Peabody, Mass., Union Water Meter Co., Worcester, Mass.; B. F. Polsey, Walworth Mfg. Co., Boston, Mass.; Jesse Garrett, R. D. Wood & Co., Philadelphia, Pa.; H. A. Gorham, the George Woodman Co., Boston, Mass.

GUESTS.

Nath. H. Brown, Salem, Mass.; H. B. Burley, Nashua, N. H.; F. I. Chaffee, East Providence, R. I.; W. F. Clark, Boston Water Works; M. H. Crawford, Boston, Mass.; W. G. Curtis, Boston Water Works; Loring Farnham, Civil Engineer, Boston, Mass.; W. E. Foss, Boston Water Works; A. S. Hayes, St. Albans, Vt.; John H. Hurley, Salem, Mass.; W. F. Lawrence, Birmingham, Conn.; H. M. Lovering, Taunton, Mass.; W. T. Murphy, Boston Water Works; Dr. S. D. Presley, Taunton, Mass.; T. F. Smith, Grafton, Mass.; D. J. Sutherland, Lynn, Mass.; E. A. Taylor, Worcester, Mass.; S. H. Taylor,

New Bedford, Mass.; W. D. Taylor, Dover, N. H.; H. B. Tower, Cohassett, Mass.; H. A. Warren, St. Albans, Vt.; G. C. Whipple, Boston Water Works; W. F. Wyman, Brookline, Mass.

The Secretary presented the names of the following applicants for membership, and on motion of Mr. Fuller the Secretary was directed to cast the ballot of the Association for them, which he did and they were declared elected:

RESIDENT ACTIVE MEMBERS.

Harry B. Burr, City Engineer, Nashua, N. H.; Fred. I. Chaffee, Chairman Executive Board, East Providence, R. I. (29 Weybosset St., Providence;) William G. Curtis, Asst. Biologist, Boston Water Works, Brighton, Mass.; Wilbur D. Fiske, Water Commissioner, Melrose, Mass.; George S. Rice, Civil Engineer, 95 Milk St., Boston; Herbert E. Smith, Professor Chemistry, Yale Medical School, 430 George St., New Haven, Conn.; E. L. Wallace, Supt., Franklin Falls, N. H.; H. A. Warren, Supt., St. Albans, Vt.; Edwin A. Taylor, Constructing Engineer, U. S. Hotel, Boston; William D. Taylor, Supt., Dover, N. H.

NON RESIDENT ACTIVE MEMBERS.

George I. Bailey, Supt. Water Works, 61 State St., Albany, N. Y.; R. H. Bradley, Supt., Watertown, South Dakota; L. L. Doubleday, Secretary Water Co., Columbus, Kas.; William B. Gerrish, Supt., Oberlin, Ohio; J. O. A. Laforest, Acting Supt., Montreal, Quebec; W. G. Yorston, Constructing Engineer, Box 478, Truro, N. S.; J. B. Newhall, Supt., Staten Island.

ASSOCIATE MEMBERS.

M. H. Crawford, the Radford Pipe and Foundry Co. of Cincinnati, Cast Iron Pipe, address 523 Exchange Building, Boston.

The Secretary read the report of the committee appointed at the Holyoke convention on changes in the constitution as follows:

To the Members of the New England Water Works Association:

Gentlemen:—At the last annual convention, your President suggested that a change be made in the time and place of holding the annual convention, and for the reasons that many of the members are unable to leave their work in June, and that Boston is more accessible to the majority of the members, he suggested the advisability of changing the time of holding the annual meeting.

As this would require a change in the constitution of the Society, the subject was referred to your committee to consider and report at the December meeting any changes which they may deem advisable.

In order to obtain a full expression of the wishes of the members of the Association, your committee issued a short statement of the facts, asking for replies giving the individual preferences of the members. A copy of the circular referred to is appended to this report. About one-half of the members replied to our inquiries and from their replies the following statement is condensed:

	Resident.	Non-Res.	Total.
New England cities in June	53	12	65
Boston, in March	38	9	47
Boston, in June	7	5	12
New England cities in March	4	1	5
New England cities in September	2		2
Boston, in October		1	1
No preference	6	8	14
	110	36	146

Of the resident members 42 were superintendents or assistant superintendents of works, the class of our members whom it might be expected would be least able to leave their work during the month of June. Twenty two of these voted for June and 20 for March. The votes for New England cities and Boston were evenly divided, 21 votes each.

Thus it will be seen that the resident members taken as a whole do not desire a change from the present schedule. We would, however, call your attention to the vote of that important nucleus within the ranks of the resident members, viz.: The superintendents of water works. Their votes on this question were about evenly divided.

It is therefore apparent that a change from the present plan of holding the meetings is not desired by a majority of the members of the Association and your committee therefore recommend that no change be made.

Respectfully submitted,

DEXTER BRACKETT,
R. C. P. COGGESHALL,
W. H. RICHARDS.

(CIRCULAR.)

NEW ENGLAND WATER WORKS ASSOCIATION,
OFFICE OF THE SENIOR EDITOR,
BOSTON, MASS., JUNE 30TH, 1892.

Dear Sir:—At the annual convention of this Association, recently held at Holyoke, considerable discussion was had among the members as to the desirability of changing the time of holding the annual convention, in accordance with a suggestion advanced in President Holden's address.

The undersigned were appointed a committee to consider this question and report to the Association at the meeting in December such changes in the constitution and by-laws as may seem desirable.

Article VII, Section 1, of the constitution and by-laws reads as follows: "Four regular meetings of the Association shall be holden during each year, viz.: On the second Wednesday of March, June, September, and December; the June meeting shall be the principal meeting of the year, and shall be known as the 'annual meeting.' Special meetings of the Association may be holden at the discretion of the President."

It will thus be seen to be necessary to make a change in the constitution and by laws if the annual convention is to be held during any month other than June.

Among those who favor the change, the suggestion is made that during the month of June, or, in fact, during any of the summer months, many of our members find it difficult or impossible to be away from their work for two or three days and that the convenience of the members would be enhanced and a larger attendance assured if the annual convention was held during the month of March. As this season would not be a pleasant one for sight seeing and as many of the New England cities cannot provide suitable accommodations for our meetings, it has been proposed in the future to hold all meetings in Boston, with the exception of the Fall Excursion.

This scheme would provide for the following named meetings, viz.: The annual convention in March, the Fall Excursion in September, meetings of one day each in November, December, January, and February.

Among those who do not desire a change from the present plan of meetings, the opinion is expressed that the holding of the annual conventions in June, in the different New England cities, occurring as they do at the pleasantest season of the year, afford most excellent opportunities for acquiring an acquaintance with our New England cities and towns, as well as giving a pleasant relaxation from the round of home duties. They feel that the series of winter meetings in Boston is as it should be, but that the Association and its work becomes better known by having the annual convention held according to the present plan.

Your committee desire a full expression of the opinions and preferences of the members upon this subject, especially from those who are in the habit of attending the annual convention.

Will you please express your views upon the enclosed postal? A prompt reply is earnestly requested.

Very respectfully,

DEXTER BRACKETT,
R. C. P. COGGESHALL,
WALTER H. RICHARDS,
} Committee.

On motion of Mr. Harris the report of the committee was accepted.

Mr. Nevons suggested that an interesting subject for consideration at the next meeting would be the effect of electricity upon water pipes, and the Association extended an invitation to Mr. Charles Morse, of Cambridge, and

to Mr. Lee, of Boston, to be present at that time and speak upon that subject.

The President then introduced Desmond Fitzgerald, resident engineer, of the additional water supply and superintendent of the western division of the Boston Water Works, who gave an interesting description of the Boston Water Works, illustrated by lantern slides. Mr. Brackett followed, giving a description of certain features of the works, also illustrated by lantern slides. Mr. Walter H Richards followed with a description of the New London High Service, stereopticon views of which were exhibited.

[Adjourned.]

ADJOURNED MEETING.

YOUNG'S HOTEL, BOSTON, MASS., JANUARY 11TH, 1893.

The following members and guests were present:

ACTIVE MEMBERS.

Charles H. Baldwin, Boston, Mass.; Lewis M. Bancroft, Chairman Water Commissioners, Reading, Mass.; George E. Batchelder, Registrar, Worcester, Mass.; George Bowers, City Engineer, Lowell, Mass.; Dexter Brackett, Asst. Engineer, Boston, Mass.; Harry B. Burley, City Engineer, Nashua, N. H.; George F. Chace, Supt., Taunton, Mass.; R. C. P. Coggeshall, Supt., New Bedford, Mass,; Byron I. Cook, Supt., Woonsocket, R. I.; Henry A. Cook, Supt., Salem, Mass.; George K. Crandall, Asst. Engineer, New London, Conn.; William G. Curtis, Asst. Biologist, Boston W. W., Brighton, Mass.; Lucas Cushing, Asst. Supt., Boston, Mass.; Nathaniel Dennett, Supt., Somerville, Mass.; Albert B. Drake, Supt. Public Works, New Bedford, Mass.; Charles E. Drake, Civil Engineer, New Bedford, Mass.; Thomas M. Drown, Prof. Chemistry, Mass. Inst. Tech., Boston, Mass.; Horace L. Eaton, City Engineer, Somerville, Mass.; George A. Ellis, Civil Engineer, Boston, Mass.; F. F. Forbes, Supt., Brookline, Mass.; Z. R. Forbes, Asst. Supt., Brookline, Mass.; Frank L. Fuller, Civil Engineer, Boston, Mass.; Albert S. Glover, Boston, Mass.; W. J. Goldthwait, Morblehead, Mass.; E. H. Gowing, Boston, Mass,; E. A. W. Hammatt, Civil Engineer, Boston, Mass.; George W. Harrington, Supt.; Wakefield, Mass.; John L. Harrington, Cambridge, Mass.; John C. Haskell, Supt., Lynn. Mass.; Allen Hazen, Chemist, Lawrence, Mass.; Horace G. Holden, Supt., Nashua, N. H.; Horatio N. Hyde, Supt., Newtonville, Mass.; Patrick Kieran, Supt., Fall River, Mass.; Thomas C. Lovell, Supt. Fitchburg, Mass.; Hiram Nevons, Supt., Cambridge, Mass.; Edward C. Nichols, Commissioner, Reading, Mass.; George H. Nye, Civil Engineer, New Bedford, Mass.; Edward H. Phipps, Supt., New Haven, Conn.; Waldo E. Rawson, Supt., Uxbridge, Mass.; George S. Rice, Civil Engineer, Boston, Mass.; Walter H. Richards, Supt., New London, Conn.; George J. Ries, Supt., Weymouth Centre, Mass.; G. A. Roulier, Supt.,

Flushing, N. Y.; A. H. Salisbury, Supt., Lawrence, Mass.; Chas. W. S. Seymour, Supt., Hingham, Mass.; William B. Sherman, Mechanical Engineer, Providence, R. I.; John D. Shippee, Supt. and Secretary, Holliston, Mass.; George A. Stacy, Supt., Marlborough, Mass.; Edwin A. Taylor, Civil Engineer, Boston, Mass.; Lucian A. Taylor, Civil Engineer, Boston, Mass.; M. M. Tidd, Boston, Mass.; S. Everett Tinkham, Asst. Engineer, Boston, Mass.; W. H. Vaughn, Supt., Wellesley Hills, Mass.; Charles K. Walker, Supt., Manchester, N. H.; Joseph Watters, Commissioner, Fall River, Mass.; Robert J. Thomas, Supt., Lowell, Mass.; E. L. Wallace, Supt., Franklin Falls, N. H.; Horace B. Winship, Civil Engineer, Norwich, Conn.; Frederick S. Winslow, Boston, Mass.; George E. Winslow, Supt., Waltham, Mass.

ASSOCIATE MEMBERS.

James M. Betton, H. R. Worthington, Boston, Mass.; A. H. Broderick, Chadwick Lead Works, Boston, Mass.; M. H. Crawford, Radford Pipe and Foundry Co., Boston, Mass.; Charles H. Eglee, Contractor, Flushing, N. Y.; G. A. Taylor, and H. N. Libbey, Gilchrist & Taylor, Boston, Mass.; J. A. Tilden, Hersey Mfg. Co., South Boston, Mass.; Mr. Snow, Thomson Meter Co., Brooklyn, N. Y.; J. P. K. Otis, and G. H. Carr, Union Water Meter Co., Worcester, Mass.; George B. Wood, R. D. Wood & Co., Philadelphia, Penn.; H. A. Gorham, the George Woodman Co., Boston, Mass.

GUESTS.

R. B. Allen, H. P. Beals, A. A. Blossom, Salem, Mass.; Frank P. Brown, F. W. Clark, Brighton, Mass.; Mr. Cook, Cambridge, Mass.; John Cornell, Waltham, Mass.; Mr. Davis, Brookline, Mass.; A. H. French, Brookline, Mass.; W. E. Foss, Boston, Mass.; John Gardner, Fall River, Mass.; Mr. Hill, Waltham, Mass.; John F. Hurley, Salem, Mass.; H. L. Lincoln, Cambridge, Mass.; L. D. May, J. J. Moore, Boston, Mass.; Mr. Morse, Cambridge, Mass.; Dr. Shea, Lawrence, Mass.; L. H. Taylor, New Bedford, Mass.; Wallace Whiton, Weymouth Centre, Mass.; E. Worthinnton, Jr., Boston, Mass.; W. T. Wyman, Boston, Mass.

The Secretary presented the following applications for resident active membership:

Frederick W. Clark, Clerk on Boston Water Works at Chestnut Hill Reservoir; E. Worthington, Jr., Hydraulic Engineer, 637 Exchange Building, Boston; Ernest H. Brownell, Instructor Brown University, Providence, R. I.

On motion of Mr. Brackett the Secretary was directed to cast the ballot of the Association for the candidates, and they were declared elected.

Mr, Cook of the Cambridge Press was called upon by the President and responded with a humorous speech.

Mr. George A. Ellis, formerly President of the Association, was called upon by the President and he spoke as follows:

It gives me great pleasure to meet you again Mr. President and gentlemen of the Association, after so many years, even if I have to meet you almost as a stranger, as I did Mr. Coggeshall, who not only asked me my name but had to ask me my initials before he knew who I was. (Laughter.) I would say that while I have been absent from you I have found everywhere I have been evidence of the influence of this Association among water works men. And I think the reason is, that whenever any subject of interest is suggested, there is found among our members some who have made a study of the subject and are willing at meetings like this to give their experience. I have read with great interest the reports of your experience meetings, and they have impressed me as very valuable. I think I can give no better advice than to say that you cannot do better than to make a study of that which comes nearest to your hand. (Applause.)

Mr. C. H. Morse, of Cambridge, gave an interesting talk on "Electrolysis of Water Pipes." Mr. Allen Hazen, Chemist at the experimental station at Lawrence, gave an account of his work in selecting sand and gravels for the filter constructing there; and Mr. Edwin P. Gardiner, Superintendent, Norwich, Conn., read a paper describing an efficient artificial light for outside night work.

An invitation was received from Mr. Pearson of the West End Railroad company for the members of the Association to visit the West End Power station on the forenoon of the day of the next meeting. Accepted.

The subject of the size of pipe permissible for fire protection for manufactories and the charge for the same was discussed by Mr. Walker, Mr. Nevons, Mr. Stacy, Mr. Freeman and Mr. Fuller.

[Adjourned.]

ELECTROLYSIS OF WATER PIPES.

BY

MR. C. H. MORSE, OF CAMBRIDGE, MASS.

Mr. President and Gentlemen of the New England Water Works Association:— When my friend Mr. Nevons about two years and a half ago came to me in the corridors of the City Hall and said: "Mr. Morse, what effect is the connecting of these wires to our water pipes going to have?" I remember of saying to him at that time: "The effect will be something very slight, I anticipate no trouble from it; you will probably be in your grave before any water pipes are injured by electricity." And then, again, about two months and a half ago, when Mr. Nevons again came to me and said: "Mr. Morse, do you suppose that this electric business is having any effect on our pipes?" and I answered him in an entirely different way, saying, "Most certainly, I haven't the slightest doubt but what it is having an effect," he gave me a look as much as to say, "Why, Mr. Morse! You never think twice alike, do you?" (Laughter.) And it did seem so, really. And I remember he rather brought me to an account for that, and when he said, "You have changed your mind, haven't you?" I gave him some such reply as this: That in electrical matters two years and a half certainly do make ancient history. And I think that is particularly so in regard to the development of the transmission of power by electrical energy. We have had many changes in this department of science within that time. I think I can illustrate it no better than to say that the generators which were developing power for the West End Railway company two years and a half ago are now obsolete; that the motors which were under the cars two years and a half ago would not be tolerated now by the company; new motors have been placed in service, larger ones, water-proof motors, gearless motors which make less noise, motors which are made dust proof by iron cases; and there are the single reduction motors, the gears of which run in oil, making the operation exceedingly quiet. So I feel justified in saying that the last two years and a half in some departments of electrical work have made ancient history.

Electrolytic action is not a new thing. In the year 1300 note was made of this action. Although the Faradic battery was not discovered till 1799 yet electrolytic action has been known for 500 years at least. Iron tools of miners working in copper mines, were found covered with a thin coating of copper caused by electrolytic action. So you see it is really nothing new which we are discussing today; it is merely a new, accidental application of the subject.

In order that you may understand the whys and the wherefores of this, you will excuse me if I make comparisons and go back a little into the theory of hydraulics and electricity, comparing the flowing of the electric current with

the water works system. And this is why it gives me pleasure to speak to men of your business, you will so quickly grasp the situation. I think sometimes when these comparisons are made the speaker does not go quite far enough back. All power emanates, of course, from the sun's heat. We should start from our water works, when we speak about the pressure and fall of potential at the source of supply, the sea. The heat of the sun evaporates the water, taking up only the pure water and leaving the salt, the air becomes saturated with this moisture and it flows back steadily into the interior where it meets colder streams of air, if you please to call them streams, or currents, and condensation takes place. Thus we have our highest potential in a water works system in the cloud. The condensation goes on till the drops of water are formed. The highest part of the water works system is in the cloud. The drops fall to the earth and part of our energy is lost, but the power is not noticed, as it is distributed over such a vast area that the heat effects developed are hardly apparent. The water falls into the water basin and runs back into the store house, as we might call it, the reservoir, and here we generally begin when we compare hydraulics and electricity. Then we have our large mains leading to all parts of our cities and towns, gradually growing smaller and smaller until you get to the faucets in the houses.

Now, if we should derive only power from our water pressure, and use it merely through water motors, the ideal place to put the motor, of course, would be the sea level; then we should get our maximum potential, if we had our mains big enough, we should get our full potential at the water wheel, we should get the full head, so to speak.

An ideal electric power system should be built on exactly the same principles. We have in the city of Boston in the West End Railroad system, three separate power houses, one at East Cambridge, one on Albany street and one in Allston, not very far from Cambridge. These power houses are the reservoirs. We could, if we chose, go back of this reservoir to the sun's heat again and think of the coal being formed, the trees growing centuries ago in the tropical regions, storing up this immense amount of potential energy, this coal then placed under the boilers and producing steam, that steam transformed into mechanical energy in the steam engine and the steam engine giving up its power to the dynamo, which sends out in the form of electricity 95 per cent. of the power given to it. Now, in our electrical plant we really get our highest potential at what we call the positive pole of the dynamo. The current of electricity flows out from the positive pole of the generators. These generators are coupled together, say in multiple, that is, all the positive poles together. As two or three steam fire engines may all throw their water into one line of hose, so all the generators throw their energy from the positive side of the dynamo on to the feed wires. These feed wires radiate to all parts of the system. From the East Cambridge power house, for instance, they extend to Arlington, all parts of Cambridge, some parts of Boston, to Everett, Charlestown and Somerville. Now, then, we have these immense main feeders radiating out from the station, upon which the current flows. They should be of sufficient capacity to carry the current without a fall of pressure, the same as with our water

mains, when we draw all that the generators are capable of developing with safety at the end of our lines.

Now, if I may refer to a water works system again, every particle of current which leaves these feeders and goes through the cars must return to the negative pole of the dynamo, as in the water works system every particle of water which runs out from the faucets must find its way back to the sea level. In the same way the electric current comes back. We lose in our water works system a large amount of our power in consequence of distributing the water at a higher level than the sea level, in the electric system this should not be necessary. The current goes through the feeders to the trolley wires, through the trolley down the pole to the car, through a concealed wire to the motor under the car. This motor should consume all the energy, and when the current leaves and goes into the rail it should have an easy path upon which it can return, so easy that there will be no loss of pressure noticeable on the return. When electric cars were first put in operation in Cambridge they depended upon mother earth, the water pipes, the gas pipes, and anything over which the current could flow, to convey it to the station or act as a sewer. No thought was given to the loss which would result to the company from doing this, to say nothing about the effect upon our pipes. I can perhaps illustrate this loss by saying that three months ago in parts of Cambridge the loss of pressure due to the power which was required to force this current back over this uncertain path was 20 per cent. Now, when I tell you that the central stations of the West End Railroad company have a maximum capacity of 12,000 horse power, which would give sufficient current for 24,000 arc lamps the same as are used in our streets, or 120,000 incandescent lamps, such as we have in this building, you get an idea of the power which is being sent out. When you think of that current returning, as it has been obliged to return, you can see that there must be an immense amount transmitted over our pipes.

The effect of this was called to my attention by the superintendent of the Cambridge Water Works, who is ever vigilant in these directions, and a series of tests were made to ascertain the quantity, and a little reasoning was done to determine the consequences. Electric currents have nearly the same laws as hydraulics. You take a 2-inch pipe and a 4-inch pipe, not counting in friction, the 4-inch pipe will carry four times as much water as the 2-inch, the amount varying directly as the square of the diameters. The current of electricity which will flow through two wires side by side is in the same proportion, the larger the wire the larger the current, varying as the squares of the diameters of the wires. We use a little different form from what you do, and instead of speaking of diameters we speak of wires now as of so many circular mills. This gives us immediately the idea of the amount of current which will pass over those wires. It is simply the diameter in thousandths of an inch squared.

Now, when we come to the word resistance, I want you to bear in mind this: The resistance is the same as it is in a water pipe, in one sense; you get small resistance through a large pipe, and the smaller the resistance the more water will flow. And the same rule holds with wire; the smaller the resistance

the more electricity will flow through it. If several paths are open we say the current divides inversely as the resistance. If the frictional effect or resistance of a wire is small, large amounts will flow. If we have two water pipes side by side running from the same reservoir, and we are drafting at the same point, if the pipes are of the same frictional effect, we shall have the same current of water flowing through the two pipes. Now, if we have two wires side by side attached to the same machine, the current will divide and will flow through those wires inversely according to the resistance. The larger the wire, the less the resistance and the more the flowage, provided they are of the same metal.

When the railroad company put in their power plant, they ran large numbers of feeders, as we call them, and one wire between the rails and attached the two rails to this return wire, so that the current, as I said before, will go to the car through the motor to the wheels, to the rails, and get along as best it can back to the station. This became very soon an uncertain path, as it was found that electrolytic action took place upon this wire and it disappeared in places. They thought at first that it was due to something in the soil, but it was very soon traced to the same enemy which you have to contend with, that is, electrolytic action. I remember the practical experience we had with these dead rails, as we call them. When this wire was eaten off and a car came on to that section, if by any chance you placed one foot upon the rail and another upon the ground near it, shocks could be obtained. That happened simply in this way. The current must get back to the station, and it would take to the rail, which was not well grounded, would go up one leg of the man who stood on the rail and down the other to the earth, especially if the earth was a little moist, dividing again inversely according to the resistance.

The effect was so great that the West End Railroad company made a complete change and reversed the conditions. It would be as if you started with your water works system by pumping the water from the sea into the sewers, forcing it up out of the sewer pipes and back through the faucets and through the mains to the reservoir. That is, they attached the other pole to the earth to remedy this difficulty, and instead of sending the current out over the feeders they commenced about a year and a half ago to force it out through the ground, have it go up through the cars and back through the feeders. When I heard of this I immediately concluded we should have trouble from it, and that is why I told my friend Nevons so decidedly I had no doubt it would have an effect; and now I will state some of the effects that have been noticed in Cambridge.

Mr. Nevons and I went to the different places where we had traced these difficulties, or where they had been called to our attention rather, and found that lead pipes had disappeared in a short space of time, some even in six or eight weeks. Iron pipes had been tried with the same result, also galvanized iron; brass pipe had been put in and deterioration was noticed at once. Rustless iron was tried, and it did rust decidedly. (Laughter.) Well, it was not the work of any mysterious agent, but was the result of what almost all of you have seen in school experiments, that is, the decomposition of water. The

current left the West End power house at East Cambridge, it flowed through the ground, and of course, divided according to the resistance, and took to whatever conductor came in its way. It took to the rails, the water pipes and gas pipes. Now, we get no action except at what we call the positive pole. That is where the current is flowing out of the pipes, where it takes to the pipe there is no action. The current flowed along on the pipes, and in this particular case, it got down on to Bridge street, which is near Charles river, and flowed along our supply pipes on the wharves and here it had to get across the river to propel the cars in Boston. Where it left those pipes action took place.

Well, the remedy, the quick remedy for that, of course, was very apparent, that is, to reverse the current. So the officials of the West End Railroad company were invited to a conference with the Water Board and myself, and I am pleased to say the company were willing and anxious to do anything in their power to obviate this difficulty. A certain amount of credit belongs to them for that, although, of course, they had a reason for wanting to do it themselves. They were losing anywhere from 5 to 20 per cent. of their power in this return; and when you reckon the loss on 12,000 horse power it is quite an item, if they could save 5 per cent. of that by the investment of a large amount of money it was very desirable for them to do it. They were consequently perfectly willing to take hold of this matter. It was suggested at that time that a reversal of the current might be a good thing. Now, I can illustrate to you in a moment why that would have an effect. The current was reversed, and now takes to our water pipes in just the same places that it left them before. As I told you before, there is no action at the point of contact, where it goes into the pipe; it is only where it leaves it. Therefore you would expect a very rapid deterioration where it left the pipes near the power house to go in to the machines there; of course we had to fix the pipes so the current would not leave them through the earth. The leaving through the earth would cause this effect. A difference in potential of 2 volts—our system of pressure; you call it pounds—in a current flowing from one piece of metal to another through moisture causes the decomposition of water, and water forms into the two gases, oxygen and hydrogen, at this place. Now, we speak of the oxidation of an iron pipe due to the attacking of the pipe by this gas. If it were pure oxygen there you can see we should have a very rapid attacking of that pipe. Then, we must find some means by which we can get the current off the pipe without having it go from the pipe to the earth, and we do it by soldering very heavy copper wires to the pipes in various places and carrying these copper wires into the power house and attaching them to the negative poles of the machines, so the current has an easy path over which to leave the pipe. Of course the result is we get no electrolytic action because we don't have the current leaving the pipe through the earth connection, but through a solid metal connection.

Observations were made by several of the water works employees unintentionally. Some of the other gentlemen present could tell you about those, perhaps, better than I. Such an immense amount of current was flowing over the pipes that upon attempting to make a joint by putting oakum around

the pipe, it was found that the electric arc was often sufficient to set fire to the oakum, frightening the men considerably, I imagine. This of course would not necessarily indicate a very high potential, but proved the presence of a large quantity of current in the earth. Tests were made in different parts of the city by means of instruments adapted for the purpose, and we found between North Cambridge, Harvard Square, Central Square and East Cambridge a fall of potential all the way from 25 to 45 volts. Now, you can reckon the percentage as well as I. There should be no fall of potential, but there was a loss, as I said, of from 25 to 45 volts, from 500 volts which is the maximum pressure, making more loss than can be allowed with economy. When we attached to the negative pole of the machine and made our tests from Harvard Square, we found a loss of 100 volts, or 20 per cent., of the pressure. You can now see, as I said before, why the company was very ready to take hold of this matter.

How are we to remedy the difficulty? I know of no way by which we can use the single trolley wire system and overcome this difficulty without putting up an immense amount of overhead returns, through which the resistance will be reduced to almost nothing. How far the company will be willing to go in this I cannot say. Their spirit has been so admirable in the past I have no right to suppose but what they are willing to carry it to that extent. Certainly the city will require it carried to such an extent that the pipes will be in perfect safety. The maximum amount of current which can be allowed to go over them I am unable to tell you at present, but a series of experiments are being conducted now at my house to determine this. I have some pipes buried in the earth, the current flowing over them, and I am watching carefully the deterioration daily. I am in hopes to make a report soon to the Water Board upon the maximum amount which can be allowed to flow upon iron pipes from which we will have no effect.

By doing what we did do, reversing the current and attaching our water pipes to the negative pole of the dynamo, we hurt one of our old friends seriously, that is, the Gas Company. You see the effect. The current will flow on the water pipes, and it has an easy chance to leave them through their connection with the negative pole of the dynamo. Now it flows along on a gas pipe and as soon as it can it will leave the gas pipe to take to the water pipe. I felt it my duty to make this clear to the president of the Gas Company, and called his attention to it, saying that something ought to be done to protect him, and a conference was had between the railroad people and the Gas Company, and I was invited to be present. At that time we made an arrangement with the company which will help it somewhat in that direction, and will help us as well as them. We propose now to connect the gas pipes and the water pipes together in all parts of the city. It will be done in buildings. A man from the West End company has been appointed who goes as a gas man to the different stores and factories, and in those places he will solder a wire to the gas pipe and also to the water pipe. This can do no injury to either, but will decidedly help both companies.

You will be a little interested, perhaps, to know of one or two experiments which we have tried in East Cambridge when investigating this subject. Mr. Nevons will be perfectly familiar with the new engine house at East Cambridge. It is not yet occupied. There is an old supply which comes in from one street that connected with the old house, and a new supply comes in from Otis street, I believe. The mains are connected together at the corner of Third and Otis street, and this engine house is on the corner. Now there is sufficient difference in potential between those two pipes so that if they are connected together by a medium sized copper wire, about a No. 18, it will heat the wire so hot you can't bear your hand upon it. There is sufficient power to run a good sized motor, and I suggested to the engineer that he put a motor in there and run a planing mill and a few other little industries to help out that section of the city. It is a matter of fact that if we could save all this energy which is being thrown away, we could run a large factory. In fact, if we run a copper wire from East Cambridge to Harvard Square I think at times there would be no difficulty in running the whole University Press by this wasted power.

It was a little surprise to me the way they attempted at first to return the current. Iron carries a current of electricity not as readily as copper; it has seven times the resistance. Now, there are girder rails, that have, we will say, 10 square inches, some of them have as high as 14 square inches sectional area. That would have a carrying capacity equal to a piece of copper 2 inches square. And yet these rails are bonded by a No. 4 copper wire, a wire smaller than a lead pencil. It seems quite ridiculous that they should ask this little bit of fine copper wire to carry as much current as a big rail, where they could have a piece of copper wire, as I said before, for these big rails, of at least two square inches sectional area.

There is another remedy also which we hope to carry out early in the spring, and that is to abolish completely this return wire between the rails, by cutting it into sections of about 400 feet, and connect each of these sections with the return wires. Most of the current will then return by these copper wires. Of course, some of it, as I said before, will flow over the water pipes; that cannot be helped as long as one side of the machine is connected with the earth.

Another remedy which is to be adopted, is a special line of feeders attached only to the water pipes; that is, a feeder will be run from the central power house to the different parts of the city, which will not be connected with the machines at all, but will be connected with the water pipes at the central power house and with the pipes in all sections of the city. This will also materially reduce the electrolytic action.

I have occupied more time already than I ought, but if any member of the Association desires to ask any questions I should be pleased to answer them.

The President. Gentlemen, this subject is open for discussion. I understand that there are two classes of persons, those who do not claim to know anything about this subject, and those who know a great deal more

than they care to tell. That being the case, I do not dare to call upon any body, but I should be glad to hear from any one, and Mr. Morse is ready to answer any questions.

MR. HAZEN. I would like to ask if the destruction of the pipes is entirely from the outside, or whether it is from the inside as well?

MR. MORSE. It is entirely from the outside, where the current leaves the pipe. We should have almost the same effect if there was no water in it. Where the current leaves the pipe it makes little pit holes in it as big as the end of your finger or thumb, a little crevice which will work clear through the pipes.

MR. HAZEN. Is the ferric oxide left there?

MR. MORSE. You would be surprised to see how much is carried away, and just what becomes of it I haven't been able to determine yet.

MR. HOLDEN. Does it affect one kind of pipe more than another?

MR. MORSE. Any kind of metal pipe would be affected. A remedy has been tried that I think will be successful in some sections, that is, the placing of the pipe in cracked stone. I think this has a decided effect. And, also, the placing of the pipe in cement, where the supplies go through muddy places, would be desirable.

MR. HOLDEN. Wouldn't a cement covering answer?

MR. MORSE. Yes, sir. But let me explain that we should get the flow of the current through a cement lined pipe, and if the supplies were not covered we should get the action on the supplies.

MR. TIDD. I should like to ask if those spots you speak of are rust spots or holes apparently drilled into the pipe?

MR. MORSE. I think it is probably due in iron pipes to a very rapid oxidation of the pipe. It is quite difficult to make a deposit of iron, although it has been done repeatedly and is being done in some instances commercially. The effect is, however, I think, undoubtedly rapid rusting due to the formation of oxygen and hydrogen at the positive pole.

MR. TIDD. I asked the question because in my experience in dry docks I have noticed that almost every steamer that comes into a dry dock has on the back side of the propeller, I mean the side towards the ship, pit-holes drilled into the propeller, sometimes half an inch in diameter and oftentimes as big as your hand, and drilled sometimes completely through the blade, but always starting from the back side. I asked the question because I have wondered whether there was any electrical action between the propeller and the water in friction. I have noticed that in every iron propeller I ever saw taken from a steamer, which had been in use one or two years; they always have these holes on the back side of the blade, and I didn't know but it might be something of that sort.

MR. MORSE. I am not able at present to account for that.

MR. COGGESHALL. I think perhaps some of us would be interested to know how much damage this has caused in Cambridge. I don't think it is generally known how serious a matter it is.

MR. MORSE. We would give a good deal if we knew. We simply know there has been damage, and of course a large amount of injury has not been located yet. We have discovered some of it, but we do not know how soon dozens of pipes may give out which have not yet been quite destroyed.

MR. GARDNER. Do I understand that the return wire between the rails has suffered this deterioration so it has been eaten *all* away?

MR. MORSE. Yes, I have seen that in several instances. Three years ago complaints came to me that in a certain section of the city if a horse stepped on a rail he would be knocked down. I investigated, and found that the wire was reduced to almost nothing, leaving what we call a dead rail. You can see the effect at once. If a car came in on that section, the current had to get back through the ground, and it would go up through a horse's forward legs, pass through his body and down through his hind feet, and the result was a severe shock.

MR. GARDNER. Was this a small wire?

MR. MORSE. About as large as a lead pencil.

MR. GARDNER. Did this deterioration in the wire occur in spots or was it general?

MR. MORSE. I don't know how general. I know that in some sections of the city they have been forced to make this return a covered wire, almost insulating it, so they wouldn't get this effect. It varied in different soils.

MR. GARDNER. The reason I asked the question was because I wondered whether it was not possible that there was something in the soil that facilitated that action.

MR. MORSE. I think there is no doubt about it; there is a very great difference in different soils.

MR. GARDNER. If that wire had been larger do you think the action would have been the same, or was it due to the incapacity of the wire to conduct the current? In other words, had the wire been large enough to conduct the current readily would there have been this disintegration?

MR. MORSE. No, I think there would not. If the current could flow back over the rail and wire very easily, much easier than it could leave it and take to the water pipes, the amount of the electrical action would be so small it would have been years before we discovered it. Several months ago we were unable to locate grounds on our fire alarm system, and I wrote to the West End company complaining of the size of their return wires, and last April they commenced running a return wire just to overcome that difficulty.

MR. GARDNER. Wouldn't the remedy be to have a very large return?

MR. MORSE. Yes, that is it exactly, to have the return so large that there can be almost no resistance to it. The question which we are considering now is how much current we can allow with safety on our water pipes. It is not possible under the present system to make it so that there will be absolutely *no* flow, and the question is how much we can allow with safety.

PROF. DROWN. I would like to ask Mr. Morse if it were possible to cover the pipes completely with a non-conducting coating heavily coated with asphalt, whether there would be any deterioration?

MR. MORSE. If the pipes could be insulated from the soil in which they are placed there would be no action.

THE HIGH SERVICE WATER WORKS SYSTEM OF NEW LONDON, CONN.

BY

WALTER H. RICHARDS, ENGINEER.

The city of New London is supplied with water by gravity from a large storage reservoir situated six miles from the city. Until 1889 the supply main consisted of 24-in. pipe for a distance of about 6000 feet from the reservoir, where it was reduced to 16-in., continuing of that size to the city. At that time, with an estimated average daily draft of 1,250,000 gallons, the pressure in the higher portions of the city, 100 to 120 feet above mean high tide, was so seriously reduced as to deprive some houses of water during a portion of the day, and the 16-in. main was paralleled with a 20-in. But as the higher portion above referred to would still have a pressure of only 30 lbs., or less, it was decided to cut it off from the lower portion of the city, and increase this pressure to about 50 lbs.

The high service district was occupied almost exclusively by residences, and as the quantity consumed was consequently small the cost of maintenance of a steam pumping plant would have been out of proportion to the results obtained. For this reason a tank was built at an elevation sufficient to furnish the desired pressure, and the tank supplied by pumping from the supply main, the pump being driven by a hydraulic engine, actuated by the water consumed in the lower part of the city. If, for any reason, the tank is shut off from the high service, a check valve between the high and low services furnishes a temporary supply under low pressure.

As by the system adopted the pumping is continuous and approximately in proportion to the draft, the tank was small, holding but 90,000 gallons, being designed to furnish water for such small fires as are likely to occur in a residence district, and to supply any temporary disproportion between the draft in the two districts.

A tank elevated on a tower was adopted in preference to the ordinary stand-pipe, because water in the lower portion of a stand-pipe, being below the level of the reservoir, would be useless, and would lie stagnant.

The tower rests upon four heavy granite masonry piers laid up in cement mortar. These piers are 10 feet square at the base, and 6 feet square at the top, surmounted by pillar blocks of cut stone, 4 feet square and 10 inches thick. The piers are 10 feet deep, and rest on a clayey hardpan formation. Two 1¼-in. bolts run from the bottom to the top stone, and the iron bed plates are secured to the pillar blocks by four 1-in. bolts running through this stone, the whole structure being thus fastened together.

The tower consists of four wrought iron lattice posts resting on wrought iron bed plates which support nine plate girders, 4 feet in depth. The posts are 36 feet c. to c. at the bottom, and 20 feet c. to c. at the top, and are fas-

tened with suitable tie rods and braces. The tower is surmounted by a wrought iron tank 25 feet in diameter and 26 feet high, built up of plates of the following thicknesses: Bottom, ¼-in.; first plate, ⅜-in.; second plate 5-16-in., and third, fourth and fifth plates, ¼-in. The vertical seams are double riveted, and the bottom and horizontal seams single riveted, with ⅞ and ⅝-in. rivets. A 4x4-in. angle iron is riveted at the bottom and a 4x3 in. T iron near the top. Oak plank hewed to fit the laps are placed between the tank and the girders. All the iron used in the structure is of 45,000 lbs. tensile strength. A suitable iron ladder runs from the ground to the top of the tank, and the tank is provided with a manhole near the bottom. The 10-in. supply and 6-in. overflow pipes are of spiral welded steel. These pipes extend up to the bottom of the tank. They are extended up inside the supply pipe to within 4 feet, and the overflow to within 1½ feet of the top of the tank. These pipes are fastened to the tank with flanges, corrugated copper expansion joints being inserted under the bottom of the tank. The water enters the tank near the top, and by means of a check valve in a branch is drawn from near the bottom. The overflow from the tank returns to the low service supply main. As the overflow pipe is near the supply the constant movement of the water prevents ice adhering to either pipe. All the iron work is thoroughly painted. The capacity of the tank is 90,100 gallons. The height of the tower is 68½ feet, making the entire height of the structure 94½ feet above the pillar blocks, or 214½ feet above mean high tide. The tower and tank were built by the Berlin Iron Bridge company of East Berlin, Conn.

†The engine or motor by which the tank is supplied is situated on the line of the 20-in. supply main, A, and about 500 feet from the tower. It consists of a cast iron cylinder 36 inches in diameter and 8 feet long, set at right angles to the line of the main, containing a hollow, air tight, steel plunger, B, 24 inches in diameter and 54 inches long, which makes a 36-in. stroke.

On each side of the cylinder are two 24-in. butterfly valves, C, which are connected by means of reducing Ys and 20-in. bends with upright 20-in. Y branches (not shown) set in the low service supply main. The pump is situated at the end of the main cylinder, the pump plunger, E, being on the same rod as the motor plunger. The stems, F, of the butterfly valves run up through the casing and are connected by means of arms and rods with a wrist plate, G, on the center of the motor cylinder.

On top of the main cylinder is an auxiliary cylinder, H, 6 inches in diameter, taking water through a cylindrical slide valve, I, moved by a tappet rod, K. On the piston rod of the auxiliary cylinder is a piston working in an air cylinder J, 10 inches in diameter, which acts as a cushion for the valves. This piston rod is connected with the wrist plate above mentioned. The auxiliary cylinder is actuated by water passing from the low service main and exhausting into the air, or may, when the tank is full, take water from the high service pipe and exhaust into the low service mains. In the first instance the amount of water wasted is 1.1 gallons per stroke; in the latter case no water is wasted.

†Reference is made to letters on the accompanying plates.

The supply main runs under the motor, making a by-pass. In the by-pass is a 20-in. check valve which closes by means of a lever, which is weighted so as to offer a resistance of about 5 lbs. per sq. in.

In case of accident to the motor, or if for any reason it should stop at the end of a stroke, the check valve opens and the supply to the city is not interrupted.

The pump is of the usual horizontal plunger pattern. The pump plunger makes the same stroke as the motor plunger, and is 10 inches in diameter.

The action of the motor is as follows: The water passing to the low service district is deflected by means of the check valve into the motor, passing through one of the butterly valves, one on each side being open. The water drives the motor plunger over, which, when near the end of the stroke, moves a tappet, K, which latter reverses the valve of the auxiliary cylinder. The action of the auxiliary piston reverses the butterfly valves, opening two and shutting two, by this means deflecting the water to the other side of the motor plunger, which reverses the above operation; the water, after driving the plunger over, passing on to be used in the low service district.

The motor is in general design an adaptation of the one used at Burlington, Vt., and described before this Association by F. H. Parker,* but is much larger.

It was built by W. H. Lang, Goodhue & Co., of Burlington, Vt., at a cost complete of less than $5,000.00.

The machine is experimental and there are many features which might be improved.

It will be seen that all the water used on the low service is drawn through the motor, a portion of its head or pressure being used to drive the same, and the speed of the motor is thus controlled by this draft. For this reason it was necessary to proportion the motor in the ratio of the draft on the low service to the draft on the high service. This was accomplished approximately, although in three miles of cement lined pipe on the high service the leakage is rather larger than expected. The draft through the motor at present varies from 900,000 to 1,250,000 gallons per day and from 300 to 1,200 gallons per minute On Sundays the draft on the high service is larger than on other days, and as no water is used for manufacturing on the low service on that day, and the speed consequently reduced, the tank is sometimes drawn upon to the extent of about 15,000 gallons.

The speed of the motor varies from 4 to 16 strokes per minute, being about 8 in the night time and 13 in the day time. At about 16 strokes the limit of 5 lbs. loss is reached and the check valve opens. The pressure at the motor is about 35 lbs. changing with the fluctuations in draft and with the level of the reservoir. The loss of head in the passage through the motor varies from 2½ to 4 lbs. The head pumped against varies from 18 to 20 lbs.

It will be observed that for an instant during each stroke, while the valves are changing a passage is open entirely through the motor; but for this it would be a perfect meter. From observation this loss is estimated at 5 per cent. and the consumption on the low service is calculated on this basis.

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* "Journal of New England Water Works Association," Vol. II., p. 63.

The present consumption on the high service ranges from 13 to 15 per cent. of the amount used in the low service, or about 100,000 to 150,000 gallons per day and the capacity of the pump is a little over 15 per cent. of the water passing through the motor. The water ram due to the stoppage at the end of each stroke is very slight, rarely amounting to 5 lbs.

Tests for efficiency were unsatisfactory. The reason being that the exact quantity of water passing through the motor during the opening of the valves is unknown and that the constant varation in head on the motor and on the pump makes the pressure difficult to determine without very accurate instruments, and further that when running at a quick stroke the valves are reversed before the full stroke is completed. An average of nine tests of six hours each at different times of day and night gave: Number of strokes per minute, 10.74; pressure above motor, 34.62 lbs.; below motor, 31.46 lbs.; difference, 3.16 lbs.; head on pump, 17.8 lbs.

As the pump and motor plungers are on the same rod any shortage in stroke is proportional in both and this factor may be eliminated and both calculated for the full stroke.

Then with the above figures :—

10.74 strokes $\times$ 12.24 = 131.46 gals. pumped per min.
17.8 lbs. = 41 ft. = head on pump.
131.46 $\times$ 41 ft. = 5389.8 ft. gals. work of pump.

10.74 strokes $\times$ 70.5	=	757.17	gals.	per	min.	passing through	motor.
5 per cent.	=	37.85	"	"	"	"	valves.
10.74 strokes $\times$ 1.1	=	11.84	"	"	"	"	aux. cylinder.
		806.86	"	"	"	consumed.	

3.16 lbs. = 7.3 ft. = head consumed.
806.86 $\times$ 7.3 = 5890.08 ft. gals. work of motor.

then $\frac{5389.8}{58.90}$ = 91.5 per cent. efficiency.

This result is probably too high but is given for want of more reliable data; but its efficiency at the usual speed is over 80 per cent., and is higher when running at slow speed.

The machine has now been in satisfactory operation over two years, working day and night, consuming no fuel and less water than is required to run a coffee mill motor, and requiring attendance but a few minutes every other day. Its economy has been fully demonstrated, and where the conditions under which it works are similar it might be adapted to advantage in other places.

So far as known to the writer, this machine, with the exception of the one at Burlington, Vt., is the only one in existence used for this purpose, although it is somewhat similar in principal to a vertical, single acting engine built in 1842 at Derbyshire, England, to pump water from a mine.

ADDITIONAL DISCUSSION

ON

THE ARRANGEMENT OF HYDRANTS AND WATER PIPES FOR PROTECTION OF A CITY AGAINST FIRE.*

DISCUSSION

BY

WM. R. BILLINGS, TAUNTON, MASS.

It would be well if Mr. Freeman's paper could be put into the hands of every man who is called upon to design a new system of water mains or to enlarge an old system, with orders to read, mark and inwardly digest. The callow graduate or the newly elected commissioner must not suppose that all of his own deficiencies can be made good by a study, be it never so laborious, of Mr. Freeman's clear statements and well sustained conclusions but the trained water works constructor who knows how to make his bricks will find that Mr. Freeman has provided him with the best of straw.

In the appearance of this and a former paper, (see Journal, March 1890) we note an indication that after forty years of experience and experiments in pipe systems, we have reached a stage of careful observation and exact statement. Too often the sizes of distributing mains are determined, by the engineer upon the freight rate theory, that is "all the traffic will bear," or by a water committee governed by the sole desire to spend the smallest possible amount of money, and an opinion having something of the judicial quality of a decision from the court is more than welcome.

Mr. Ellis called attention several years ago to the fact that the work of subduing a disastrous conflagration cannot be hampered by considerations of economy, and so far as the temporary and special fire appliances are concerned no one does insist upon economy in this connection, but the value of a large water main as a fire extinguisher is not immediately evident to the average mind and the two fold office of the water main acting as a distributor and as a concentrator was never so plainly shown as in the paper under consideration.

The great difference between the requirements for distribution and those for concentration is the cause of the real difficulty in designing a pipe system that shall be generous enough for extreme service and not overburdensome for the tax payers. When, to the item of the expense of large pipe is added an unusual demand for money arising from the difficulty of obtaining high grade potable water in large quantities, it does not seem

*See Vol. VII. p. 49.

unreasonable to consider a plan which involves a double system of mains. The money saved by using a convenient and abundant, though impure supply for hydrant and flushing purposes, might in some cases, go a long way in providing a distributing system of small diameters, and the willingness with which people pay for small quantities of spring water for drinking purposes would seem to show that a special supply would find a profitable market in some of the larger and less fortunate cities and towns.

Mr. Freeman ventures to predict that the fire hose of the future will be 2½ inches in diameter. If special appliances are to be provided for handling this larger size, we will agree that the prediction is a safe one, but so long as hose is handled by the present methods we believe that the 2½ inch size will maintain its position. Mr. Freeman admits that 3 inch hose has been found by actual trial to be unwieldly, but his thorough appreciation of the loss due to friction, makes him anxious to believe that we may get beyond 2½ inches if we cannot reach 3 inches and perhaps this wish is father to his thought.

Undoubtedly 250 gallons per minute is the figure upon which one should base his calculations in designing a concentrating system of mains, but there are few systems of today in which the ordinary pressure is sufficient to give the 1¼ inch, 45 pound nozzle pressure, 300 feet of hose, 250 gallons stream, to say nothing of small pipe diameters which will render useless any large number of steamers at a given point. A great many towns *are* "running for luck" and except in a few cases like those of Boston and Lynn, luck seems to run with the towns, and until disastrous conflagrations come to be more common, town committees will not find it an easy matter to authorize the expenditure required to meet the safest calculations. They will continue to run for luck, trust to insurance, and then depend upon competition to keep insurance rates within reasonable limits.

During his term of service as superintendent of the Taunton Water Works, the writer made a few crude and incomplete experiments with hose nozzles and a water meter, for the purpose of getting some definite conception of the size and appearance of a 200 gallon stream. The results of these experiments, given in the table below, have little or no value in themselves as they are obviously inaccurate and might easily mislead; but with all their imperfections on their heads they have a certain value for purposes of warning and of illustration.

Case No.	Press. at Hydrant.	Length of 2½ hose.	Size of Nozzle.	Galls. per min. by 2 in. meter.	Distance reached by jet.
1	48+	150	1¼ ring	170	90
2	37	150	1¼ ring	150	80
3	55	50	⅞ ring	125	75
4	52	50	1 5/16 smooth	180	50
5	55	50	⅞ ring	Meter	95
6	52	50	1 5/16 smooth	Removed	75

These figures can warn the young experimenter against broad conclusions from limited data, for though in Case 3, the meter registered 125 gallons per

minute, Mr. Freeman's Table B allows only 119 under these conditions, while in case 4, a 1 5-16 nozzle shows by the meter a smaller discharge than Table B allows for a 1¼ inch nozzle under the same conditions, and in both instances Table B is undoubtedly correct. As an illustration, the figures of the table may give additional force to Mr. Freeman's description of himself as "one who vigorously holds that water meters on a pipe supplying automatic sprinklers are a device of the devil," for the obstructive action of the meter is plainly shown in a comparison of Case 3 with Case 5, and of Case 4 with Case 6, when it is seen that in each instance the stream flung itself at least twenty feet farther after the removal of the meter. Finally, the figures of the table bring out, as it seems to the writer, the point that a good fire stream may be had with less than 250 gallons per minute, without bringing into question for a moment, the wisdom of the dictum that it is best to base computations for a pipe system on 250 gallons per minute; or again, a good fire stream is one thing and a basis for computation is another. So far as any impressions remain as to the apparent size of the streams recorded in the table, they are to the effect that the streams of Cases 1 and 2 were thoroughly respectable, that they would have wet down an ordinary dwelling or shop with ease, and that the streams of Cases 4 and 6 were perfect soakers, while the distances to which the streams reached seems to bear out these impressions.

Mr. Freeman shows that 100 pounds pressure at the hydrant is needed to obtain a standard 250 gallon stream through 400 feet of hose. Out of 113 cities and towns in Massachusetts there are but 10 or 12 wherein the ordinary hydrant pressure equals or exceeds 100 pounds. These towns, so happily situated for purposes of water supply are to be found mostly among the hills of Berkshire, and it is to be hoped that here, the high gift of nature has not been marred by obliging the ready stream to exhaust its energy in crowding itself through contracted passages, which may be pardoned in a Venturi meter, but which are the ruin of a concentrating system. A plan that is ample enough to provide the concentration of energy required by Mr. Freeman's calculations will, as a matter of course, be in excess of the requirements of distribution for domestic or manufacturing purposes.

The prime condition then, that we have at call something equivalent to a pressure of 100 pounds at the hydrant, seems to furnish a good starting point from which to enter upon the investigation which shall determine the general character of a public water supply. In the cases ot Cheshire and Hinsdale, Mass., nature solves the problem at the outset by offering a supply at an elevation which gives a pressure ranging from 125 to 150 pounds, and a gravity system follows as a matter of course.

The less fortunate towns must choose between a reservoir, with steam fire engines for extra power, and direct pumping, that is one large fire engine connected with the mains, and in reading Mr. Freeman's figures of the cost of hose and of six inch pipe, one can almost find a new argument for the direct pumping system. There are certainly some advantages in using a conduit 6 inches in diameter, having a life of 50 years rather than one 2½ inches with a life of only 5 or 10 years, the first cost being the same for each.

If a town finds itself without any suitable or convenient location for a reservoir it may find additional reasons for adopting a direct pumping system in Mr. Freeman's paragraphs on "distance and position of hydrants. If financial considerations will permit, why not follow the generous plan outlined therein and place hydrants so frequently, with such liberal supply mains, with such abundant power at the pumping station as to make both steamers and long lines of hose equally unnecessary.

To the question, what is the least number of fire streams with which a town should provide itself Mr. Freeman has given a perfect answer in the following pregnant sentence: "The question, therefore, comes down to getting as near ten streams for a fire district with close lying valuable buildings and having 10,000 inhabitants or less, or as near 30 streams for a city of 100,000 inhabitants as can be had without burdensome expense."

To determine the line of burdensome expense in any given case is not a problem in engineering so much as it is a problem in economics. It is a problem which demands for its solution the ripest judgment, the keenest foresight, the steadiest courage, and the most complete knowledge of the special conditions which the town can command.

DISCUSSION.

BY

G. H. Benzenberg, City Engineer, Milwaukee, Wis.

The exceedingly interesting and valuable paper of Mr. John R. Freeman leads thought in the direction necessary to the consideration of the proper distribution of mains and hydrants for fire protection, and on account of the great care and study devoted to its preparation, is one of the most valuable papers upon that subject.

Mr. Freeman points out clearly the defect or the common error of many systems, namely: Too small mains and too great distances between fire hydrants, and I wish to add but a few words to emphasize these facts. Economy of force and power apparently does not always receive attention at the hands of water works people, otherwise neither 4 inch hydrants, connection to hydrants nor 4 inch mains used to supply hydrants, would ever be permitted to wantonly waste the energy, carefully created or stored in the works. Greater care would be exercised in proportioning the mains, in taking the elevations into consideration when locating mains and of reinforcing the system by larger feed mains when increased consumption has reduced the pressure and thus prevent the frequent and often justifiable complaints heard in many cities as to inadequacy of supply and pressure when such may frequently be charged only to a positive inattention to proper distribution. Large feed mains should be carried without diminution to the very heart of the town and beyond and along the line of maximum

consumption, so as to deliver volume without sacrifice of pressure on the opposite side of the town as well as on the side entered always with the single view of furnishing a supply equal to the demand of each particular locality, but at a pressure approximating uniformity throughout the entire distribution, excepting as influenced only by the varying elevation of its streets. While this is not always attended to, sometimes for want of funds, but many times for want of study, and therefore much pressure is wasted in the mains, a greater per cent. is lost on account of the scarcity of hydrants, and this fact I wish to impress still further, by particularizing.

Undoubtedly the efficiency of a fire department in battling with a large or fierce and hot fire, greatly depends not only upon the volume, but also many times upon the promptness with which they can concentrate such volume of water upon the fire, with a pressure that will penetrate the flames and deliver the stream almost unbroken upon the burning material; hence the necessity in a direct pressure system of bringing the volume and energy of the water as stored in the reservoir, or as developed at the pumping works, or in case where steamers are used, the volume of water with the energy of the steamer, as close to a fire as possible. The more nearly this can be accomplished, the more perfect are the conditions for successfully fighting fire. Very often would the foreman much prefer to use a 1¼ inch or even a 1⅜ inch nozzle at a hot fire were he sure of the necessary pressure to deliver such stream to where it is needed, but knowing full well that the long line of hose in delivering such volume, would consume too great a percentage of the available pressure to make such stream valuable, he is obliged to direct the use of a 1⅛ inch or even a 1 inch stream upon the flames with correspondingly less favorable results; hence the necessity of the introduction of modern appliances, as the siamese connections, water towers, stand pipes at large buildings, etc., to recover or save some of the available pressure.

Accepting the general average number of hydrants per mile of pipe as seven, although this in some cities is exceeded and in some doubled, it would place on the most favorable general gridiron system of distribution, the hydrants about 380 feet apart, with not more than six streams available from three hydrants within a limit of 350 feet of a favorably located fire. Assuming in a direct pressure system a hydrant pressure of 75 pounds, this would afford four fair streams through 150 feet length of rubber lined hose with 1½ inch nozzles at a loss of about 24 pounds of pressure in each and two fair streams through 350 feet length of hose with 1 inch nozzles at a loss of about 30 pounds of pressure each on account of friction in the hose. Should the fire be fierce and have obtained a good start, a larger number of streams would be required, several of which ought to be good 1¼ inch streams to successfully check it.

Unless the fire could be fought at close quarters, but few additional fair and effective streams could be brought to play upon it. Should 1¼ inch streams be used, the loss of pressure would vary from about 30 pounds in this, taken from the nearest hydrants, to a loss of about 37 pounds in four

1 inch streams taken from the fifth and sixth nearest hydrants; or in other words: Nearly one-half of the available pressure at the hydrant would be absorbed by friction; an unwise loss of stored energy. With hydrants, however, placed at but half the above distances apart, and with the fire located at the same place, the loss of pressure in the first case would be but from 12 to 20 pounds, and in the second case but from 15 to 20 pounds, instead of 30 to 37. Or the number of streams in the first case might be increased from 6 to 14 and in the second case from 12 to 26, without any increase in the length of any line of hose; certainly a desirable result, if it can be obtained without any great increase in the percentage of cost. In placing the hydrants 190 feet apart the number would be increased to 21 per each mile of pipe, but as such spacing would not be necessary except in the business or manufacturing districts where all the available pressure is required to combat fires that are most likely to prove disastrous, it would not amount to an increase of more than one-fifth upon the entire distribution, or an average increase of about 2½ or 3 hydrants per mile at an increase of cost of not over ¾ to 1 per cent. of the cost of the entire distribution. Would any engineer hesitate to incur that additional expense in any other part of his works if thereby he could increase its efficiency from 25 to 30 per cent? And yet such result in the distribution can be obtained by spacing hydrants but half the distances they generally average apart. Not at the hydrant, but at the nozzle where increased efficiency in either volume or pressure is needed to protect property. Where the water works are owned by the municipality it undoubtedly is a matter of direct economy, for the saving in the purchase and renewal of hose during the lifetime of a good hydrant will more than outweigh the cost of the additional hydrants.

Again, what benefit is derived from a large main with hydrants far apart, when compared with a smaller main, which with hydrants less distance apart, gives better nozzle results, although the friction loss in one may be but ½ that in the other, as in the case of a 16 and a 12 inch main. The cost of the former exceeds that of the latter by from 85 to 90 cents per foot or more than the cost of hydrants placed at the rate of every 50 feet on the 12 inch main. The loss of pressure by friction with a flow of 2000 gallons per minute in the latter is but about 3½ pounds per 1000 feet of pipe more than that in the former, while the loss in each 50 feet of rubber lined 2½ inch hose on a 300 gallon stream is about 10 pounds, so that nearly 30 pounds better nozzle pressure can be obtained without any additional cost by using a 12 inch main with hydrants every 50 feet, all other things being equal, instead of using a 16 inch main with hydrants every 380 feet. I do not wish to be understood as recommending the use of smaller mains, but that the same care should always be taken to extend the efficiency of a system to its very termini, and that in providing an adequate supply and pressure in the mains, almost beneath the very fire that baffles the efforts of the firemen, a system is not perfected, because perhaps not more than half that pressure and volume can be hurled against it.

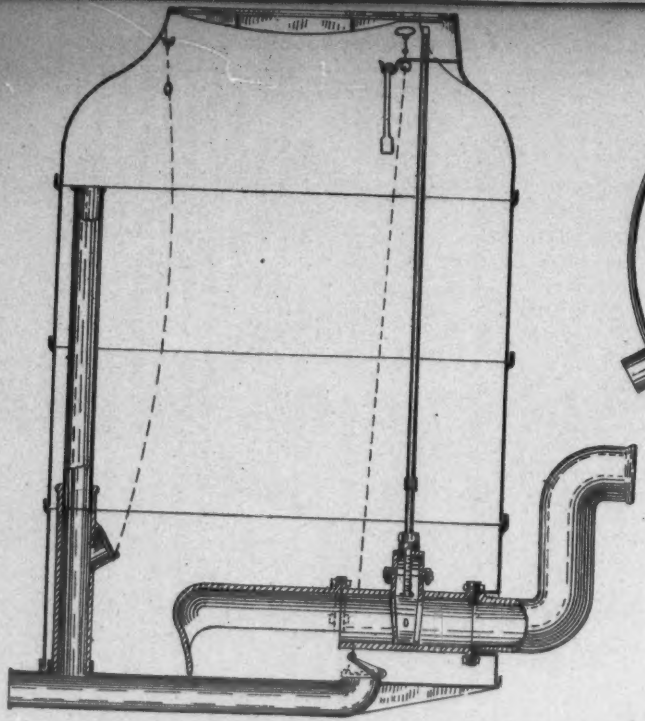
Wherever direct fire pressure is not supplied, but the steamer is relied upon for the necessary pressure the same objections to long lines of hose

holds good, and such should be avoided as much as possible. In such cities the effort should be to supply the volume of water near any possible fire so as to permit the grouping of a large number of engines as close to a fire as possible. This can be accomplished by the use of Lowry hydrants, although I believe better results can be realized with fire cisterns into which the full volume of the main may be delivered and around which five to six first-class steamers can be grouped, thus enabling the concentrated delivery of the full volume of the main with almost the entire energy of the engine; nearly the most perfect conditions necessary to overcoming a fire. With such cisterns located in the center of each block from 20 to 24 steamers throwing from 40 to 48 1¼ inch streams can be grouped around a square. From personal observations I find that much better time is made by the department in getting good streams from the cistern, than when the steamer is connected with a hydrant, and the men also seem to prefer placing their engines at such cisterns. The annexed diagram shows the style of fire cisterns now being used in Milwaukee. The entire cistern is made of iron, the rings being cemented together at the joints. The water pipe is 6 inch diameter and in its extension in the well beyond the valve, terminates in a section which is open for the lower third of its circumference and rounded at its end, so as to divert the flow downward without a break in the stream. Especially successful work, because of the almost perfect conditions, has been done by the fire department with the aid of these cisterns, of which some 90 have been constructed in this city during the past two years.

Another aid toward fighting fire has been introduced here during the past year which will be still further extended next year. The effectiveness of the very powerful fire boat has been limited by the great loss of pressure through extreme lengths of lines of hose. To utilize the service of the boat therefore at long distances from the docks, a line of 8 inch pipe with numerous hydrants has been extended from the dock to a manufacturing center some 1500 feet distant. The boat connects its three lines of 3½ inch hose by a siamese connection at the dock with the pipe line and is at once ready to furnish five or six good 1¼ inch streams at the end of such pipe line with no greater loss of head than that of one such stream through 150 feet length of hose. The hydrants used are furnished with independent valves at each hose connection, but have no valves at the base, the pipe is kept full of water by a check valve at the dock, except during the winter when the pipe is drained on account of the same being but 2 to 3 feet below the surface.

Following the timely suggestion of Mr. Freeman as to the collection of statistics regarding large fires, I will submit the following with reference to the late large fire in our city.

The fire started at about 5.30 p. m. October 28th, and covered an area, before it had finished its work, of 66½ acres. Half of the wholesale business, shipping interests and manufactories, besides hundreds of dwellings were hazarded by this fire. The total loss was about four and one-half million



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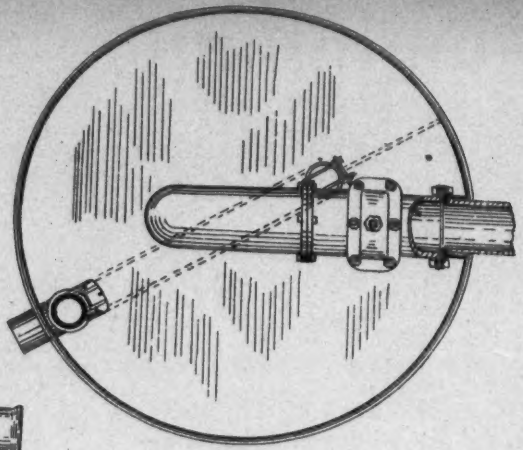

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dollars. The maximum rate of fire over ordinary draught from water works system was about 12,600 gallons per minute. To this may be added about 8,600 gallons per minute delivered from the river direct. The maximum number of streams at work at one time and supplied from the water works system was 42, in addition to which there were 24 streams supplied from the river. The fire lasted about seven hours before it was at all controlled or checked and eighteen hours before you might say it was nearly extinguished. The total fire draught was about 8,750,000 gallons supplied from the water works system and about 7,650,000 taken from the river. The method of supply of the fire streams was from steamers supplied from fire cisterns and hydrants, and also from a number of steamers and the fire boat, taking its supply from the river and it has been generally conceded that in the most valuable wholesale district the fire was prevented from spreading still further because the steamers were concentrated at fire cisterns and could throw forth their combined streams through the largest sized nozzles upon the very hottest part of the fire, and I have come to the same conclusion from personal observation of the various streams and their effectiveness both at that fire and many of our very hot fires that we have had in the city since that day.

DISCUSSION

BY

WALTER H. RICHARDS, SUPERINTENDENT, NEW LONDON, CONN.

To sum up the conclusions of Mr. Freeman's paper, the ideal works in a city of say 20,000 inhabitants, should be able to supply 8 to 15 streams of 250 gallons per minute each, with a hydrant pressure of 100 pounds. Hydrants should be from 250 to 400 feet apart and no mains should be less than 6 inches in diameter.

While we must all admit that it is desirable and necessary to approach this standard as nearly as possible the question arises can this ideal be reached, keeping in mind that the first object in building water works is a sanitary one, to furnish pure, potable water. This consideration should never be subordinated to considerations of fire protection and I think it could be shown to be poor economy to do so even if looked at only from a financial standpoint. Many cities must soon make large expenditures for the sanitary improvement of their water supplies, and the question of fire protection must be considered afterwards. It may even be that a pure drinking water will reach so high a value as to preclude its use for extinguishing fires.

One hundred pounds pressure at the hydrant is found only in rare cases. In the majority of cities the deficiency must be supplied by steamers and this is probably the most economical way except in cities having little variation in contour.

Mr. Brackett shows that none of the larger cities approach this ideal standard and a moment's thought on the part of any superintendent will show that in a majority of cases, to remodel *at once* a water works system built 15 or 20 years ago, so as to fulfill these conditions would be beyond the resources of the department.

Some increase in capacity could be attained in other ways than the enlargement of mains and increase in pressure, for instance by preventing corrosion and retaining the smoothness of the interior surface, by eliminating the sharp corners in gates, hydrants and branches, and preventing undue waste and consequent loss of pressure.

Mr. Brackett advocates hydrants with four nozzles, two 2½ inch and two 4 inch, yet New York and Brooklyn manage very considerable fires with one 2½ inch nozzle, under a few pounds pressure. The cisterns proposed by Mr. Benzenberg would seem to be a cheaper way to accomplish the desired concentration. The tendency seems to be towards a constant increase in the capacity and consequently in the cost of a water works plant for the purpose of fire protection. May it not be that the increased efficiency of the fire department would help matters and can't the insurance companies run some risk?

In planning new work the conditions proposed, excepting the pressure, can be attained usually with economy, but the work of renewing old work must for economic reasons proceed slowly, but should always *aim* at and so ultimately attain to the conditions desired. So far as the pressure of 100 pounds at the hydrant is concerned it is doubtful if that can ever be had in a majority of cases.

Page 161, line 21, for "4-way hydrants" read "4-*inch* hydrants."

DISCUSSION

BY

JOHN R. FREEMAN, CIVIL ENGINEER, BOSTON, MASS.

I have taken great pleasure in reading the contributions to this growing subject of "Fire Protection" from men so experienced in the active management of water works as Mr. Benzenberg, Mr. Richards and Mr. Billings.

In all such questions much depends on the point of view, and though I was morally certain of the truth of my deductions, I had almost feared that from my long work in arguing for increased protection, I might have been led to overrate some of the possibilities; and as my position or statements were somewhat advanced beyond the line heretofore generally occupied, I put them forth with some timidity.

I value exceedingly the appreciative words of Mr. Benzenberg, city engineer of Milwaukee, and Mr. Billings, former superintendent of Taunton, and am much pleased that they concur so fully in the views which I ventured to express.

In the remarks of Mr. Billings, there is but one paragraph with which I would take serious issue—this is the third paragraph, wherein he quotes a statement of Mr. Ellis' to the effect "that the work of subduing a conflagration cannot be hampered by consideration of economy."

Now it has been my almost daily experience that fire protection *is hampered* by questions of economy, and a large part of my study for some years past has been to find out just where *true economy* comes in.

It is my belief that *true economy* would burn the patterns for 4-way hydrants and would never install a 2-way hydrant with less than a 5-in. gate.

(It takes but a very few pounds more of cast iron to surround a 5-in. hole than for a 4-in. and the power to conduct water is about twice as great.)

True economy would not throw away a full half of the head which your reservoir produces in useless friction in trying to save the extra expense involved in hydrants 250 feet apart instead of 750 feet apart; and then spend in a moderate sized city a thousand dollars a year extra for hose renewals entailed by the greater lengths of hose laid and used.

True economy will recognize, as Mr. Billings does, that a 6-in. imperishable conduit of cast iron is to be preferred to a 2½-in. conduit of cotton, lined with rubber (possibly adulterated) when the former costs less, foot for foot, than does the latter.

True economy will some day adapt a four-ton steam fire engine to expend most of its energy in projecting three streams of large volume on to the fire,

instead of as now, merely satisfying the engine men by showing 150 lbs. on the water gauge while one stream frets itself away through 700 or 800 feet of hose and issues with a pressure of 30 lbs.—absolutely wasting more than half of its energy in useless and unnecessary friction.

In reading Mr. Benzenberg's discussion, I am much interested in his account of the isolated cisterns which he describes.

I have myself not been specially favorable to this expedient and had supposed that the expense involved would be greater than that from an adequate pipe system; but I am very glad to learn of the way another engineer has attacked the problem, and whenever again I visit the "Cream City," this will be a detail on which still more light and experience will be earnestly sought by me.

I thank Mr. Benzenberg for his statements of the per cent. of increased cost involved in developing the extra efficiency for fire protection. This puts the matter in the most practical light possible and I can only echo his sentiments and pass them along to my good friend Richards. "How can any engineer hesitate to incur an additional expense of one per cent. on the cost of water works, when he can thereby increase its efficiency for fire protection 25 per cent.?"

Turning now to Mr. Richards' remarks I most heartily concur in the view that with established works we often have got to go slow and for a long time rest content to take things about as we find them.

But as works grow older and prosper, as bonded indebtedness is retired, we can always little by little work toward our ideal and what ever we do should be done with a comprehensive system—*an ideal system* if you choose—clearly in mind.

As to the suggestion that "the first object of water works is to furnish pure potable water;" no doubt that is the grand object, but that the fire protection question is sometimes first in the hearts of his countrymen is seen when we recall the fact that in our small New England communities, it is the "Fire District" which time and time again has been first in the field with its water pipes for fire protection.

Marblehead, Andover, Easthampton and some dozens of other New England towns had their water works put in in the first instance, almost solely *for fire protection*. The corporations at Lowell, Lawrence and Manchester had put in extensive supplies with large reservoirs, chiefly for fire protection, nearly two score years before a general supply for domestic purposes was undertaken in either city.

Both fire protection and domestic supply should have their fair share of consideration.

I may be pardoned for some illustrations as to how fire protection pays.

Take cotton mills: Forty years ago insurance on the ordinary cotton mill not protected by special appliances, cost from 2 per cent. to 2½ per cent. per year, and the chief insurance authorities of the times said "there was no profitable way to take the rate cheaper."

A leading manufacturer, and judged by his own day and generation, a bold and original engineer, thought *fire protection would pay*, and after thinking the problem out, started an insurance company on the principle of encouraging pipes, pumps and hydrants, and the cotton mill of today, though having larger undivided floor areas and more rapid processes, and many new sources of hazard, secures if properly protected by pumps, sprinklers, etc., insurance at just one-tenth part of the old time cost.

Take rubber factories: Ten years ago the insurance companies said: You cannot insure these for less than from 3 per cent. to 5 per cent. a year, and even at this rate they are a poor, hazardous business.

Then came some men who said they would see what could be done to make these same rubber factories safer, by installing hose, fire pumps, automatic sprinklers, etc. Wherever they could find a place to put a sprinkler, there they put one in; and though their private fire apparatus of one kind and another sometimes cost $10,000 for a single large factory, they boldly spent their money. What is the result? Not a single destructive fire for eight years in one of the many factories so protected; and their insurance now costs from one-fifth to one-eighth of what it did ten years ago.

So it is, though in a much smaller degree, in the protection of a city. Well considered engineering, careful planning in proportioning the pipe system with frequent cross connections so that not merely *distribution* but also *concentration* can be obtained, will pay most magnificent interest on its cost.

Mr. Richards regards a pressure of 100 lbs. with a possible volume so great as I have specified, as almost an unattainable ideal. I cannot agree with him; I believe it is time for us to turn our faces toward the sunrise and do our part towards stopping a waste like that of $146,000,000 for the actual loss by fire in the United States in the year 1892, or the $155,000,000 which is the projected loss from the record thus far for the year 1893.

Although 100 lbs. is mentioned in my paper as *the ideal*, 80 lbs. may be so managed as to afford excellent protection in case a greater pressure is not obtainable without undue expense.

With the mains generous in size and frequently "grid-ironed" across, and with hydrants set not more than 250 feet apart, a protection would be afforded much better than that which the average city gets from its equipments of steamers; and even with 70 lbs. of reservoir pressure, if the post hydrants be all put in with 6-in. barrels and 6-in. gates; if the corners of the branches and passageways be all studiously rounded off so as to minimize the friction loss, if then hose 2½-in. in diameter be adopted, even though coupled up with couplings of the same 2½-in. bore, as in use today, and with the hydrants zigzagged along the street 200 feet apart, there can instantly be obtained on any part of the territory so equipped, a degree of protection, I venture to say without fear of proof to the contrary, which would be better than anything that our average city of 50,000 inhabitants realizes today from its equipment of say four first-class steam fire engines.

Mr. Richards cites the single-nozzle low-pressure hydrants of Brooklyn and New York as an argument for tolerating certain relics of a by-gone period; but I don't think that any insurance man who has followed the course of large fires in the city of Brooklyn for the few years past would send one there to learn fire protection unless it be to learn "how not to do it."

In New York a kind providence and a remarkably well organized fire department has thus far put off the evil day. Their success is due to good luck, not to good fire protection engineering. This I believe is the feeling of every one who is familiar with the enormous hazards and the inadequate safeguards of that city.

The nervousness of the insurance managers on this point may be seen by the organizing at an expense which it has been estimated might reach $100,000 per year, of a very elaborate system of inspections on behalf of the underwriters with a view to decreasing the chance of a fire once getting well under way in the congested district of New York.

If the supply be from a reservoir then fire protection may add to the cost by demanding a greater elevation and will add to the size of the diverging branches of the pipe system and may require double or treble the number of hydrants now common. If the service be by direct pumping then often treble the pump capacity for domestic service may be called for.

The total annual amount of water needed for fire protection is so very small as to be utterly insignificant in comparison with the annual or monthly draft for other purposes.

Considerations of fire protection do not burden one seriously therefore by adding much to the number of million gallons of water per day which must be found.

Water for fire protection is like the Texan's pistol, "when you want it, you want it like h—l," but you don't need to use it for a great while at a time.

SELECTION OF SANDS FOR A FILTER.

BY

MR. ALLEN HAZEN, CHEMIST, EXPERIMENT STATION, LAWRENCE, MASS.

I was asked some months ago by Mr. Mills, the consulting engineer building the Lawrence filter, to take charge of getting out the sand for the filter, and there were some problems which came up, which I thought perhaps would interest you.

There were a number of things to be thought of. In the first place the size of the sand to be used for filtration had to be determined. The coarser the sand, the larger the open spaces, the less the friction of the water, the more water can be made to pass the sand, and the less is the effect of the filtration. In order to make the filtration effective, to take out the bacteria and suspended matters, it is necessary to have a sand that is fine enough to do the work. On the other hand if the sand is too fine, the frictional resistance of the sand is very greatly increased, the amount of water which will pass is reduced, and it is not a commercial success; you cannot get water enough from the limited area. So we have to strike a mean, to get a sand which is fine enough on the one hand to take out the bacteria from a water which contains sewage, as the Merrimac river does, carrying the germs of disease, to take out the bacteria and make the effluent free from germs; and on the other hand, it must be coarse enough so that we can get the water through to make it a commercial success. So the question of the size of the sand to be used required considerable attention.

There are filters in use abroad in a great many cities, but unfortunately we could get data in regard to the size of the sand used in only one case, that is at the city of Berlin. We had some information with regard to the character of the sand used there, but it was not entirely satisfactory, and we depended mainly, in determining the size, upon the experiments which have been made at the Lawrence experiment station.

Those experiments were with sands ranging from the fine river silt with its particles three hundredths of a millimeter in diameter up to coarse sands and fine gravels, covering the whole range. And we decided upon a certain grade of sand, samples of which I have here in these bottles. We had to make a definition of the size of the sand; this is marked "50." That means that with a layer of sand say one foot thick and under one foot head or pressure, just as much head as the depth of the sand, and with all the pores of the sand full of water, and with no deposit on the top, so that there is simply the friction of the sand and not of any surface covering included, and at a temperature of 50°, water will run through the sand at the rate of 50 million gallons per acre daily. The amount of water which it is proposed to filter is

of course, very much smaller than that, being one and one-half or two million gallons per acre daily. But it is necessary to have the sand with a capacity very much larger than is to be filtered, because in the first place, the available head is very much less than the depth of the sand. Now, this sand in a filter 60 inches deep, if the loss of head is 60 inches, and it is all clean, will let through water at the rate of 50 million gallons per acre daily. But if we have only 6 inches loss of head, and that would be more nearly as we should expect to run the filter, one-tenth as much loss of head as the depth of sand, it would let water through only at the rate of 5 million gallons per acre daily. The amount of water which will pass is inversely proportional to the head, the depth of sand remaining the same.

As the more or less muddy river water comes onto the sand, the silt will fill up the interstices to some extent so that the quantity of water which will pass after a time is very much less than it is at the beginning and the sand has to be much coarser on that account. If it were just the right size at first to let through the calculated amount of water it would very soon silt up so that almost nothing could pass. The size selected, as we have found by experiment, with the head which is available, will let enough water through the sand so that the quantity of water required by the city can be filtered; and on the other hand it is fine enough to do the work required.

The problem of getting a large quantity of sand, some 20,000 yards as required, only a part of which has been gotten out at the present time, and getting it all of the same size, is quite a problem. If the sand in different parts of the filter is of different degrees of fineness, has different coefficients of friction, say the sand is twice as fine in one side of the filter as the sand in another place, the frictional resistance varying as the square of the size of the sand, the coarse sand would let through four times as much water as the fine sand. That would practically mean that the part of the filter which was made of coarse sand would let the water through so fast that the filter would not do its work, and the fine sand wouldn't do anything at all. So it is necessary to have the sand, at least in that part of the filter which acts as the unit, all of the same grade.

The sand in the bank is a glacial deposit and changes its character some times every few feet; sometimes we could get layers of the right grade extending for a considerable distance, but ordinarily it is changing all the time. And we had to watch the men getting it out very closely to prevent them from mixing in the fine sand. The man who had charge of the shoveling, was a man who had been screening sand all his life, that was his business, but he had been getting out sand for use in mortar and cement, and the problem there is entirely different. In getting out sand for mortar, it is the largest particles that count; a sand is wanted with the particles finer than a certain size, and they don't care about the fine particles. But in filtration it is the finest particles that count, and if a fine sand and coarse sand are mixed the fine particles will fill the spaces between the larger particles so that the water has to go around the comparatively large grains and through the fine sand; so it is a fact that if two sands, one being twice as coarse as the other, are mixed in equal parts, or any other proportion within reasonable limits, the character

of the mixture is nearly the character of the finest sand. In examining sands we have to put all our attention upon the finest particles; the coarse particles do not count at all for filtration or not to anything like the extent that the fine particles do. The men used to tell me when I insisted upon their taking out fine layers, that it would make no difference, that we could not tell the difference when it got mixed up with the rest. But it did make a difference and we could tell by the examination, if they were neglecting their work, and we had to watch them very closely.

The size of the sand is determined by calculations from siftings and micrometer measurements of the particles of sand. We find the frictional resistance is inversely proportional to the square of the size of the smaller sand grains, and we have made experiments at the Lawrence experiment station so that from an examination of sand and micrometer measurements we can predict approximately the frictional resistance without making actual frictional tests which would require more time than we are able to give to the hundreds of samples which need to be examined. But even this examination required to be made in the laboratory and could not conveniently be done in less than half a day, and so for the use of the men in deciding on the ground whether a sand would do or not I found it necessary to use another contrivance. For this I found most useful a cylinder of tin, 6 inches high and 3 inches in diameter with a wire bottom. The foreman who made the test, filling this half full of sand and packing it down closely, would fill the cylinder with water and then observe the time it took the water to pass through the sand. The coarser the sand the quicker the water would go down. He would make in this way, probably, 30 to 50 tests a day of the sand as it was being gotten out, or more than that if necessary. Of a certain proportion of those, duplicate samples were taken in eight ounce bottles which were sent to me at the laboratory and complete examinations made. In that way I could compare my results with his and tell him the time limits for the sand for the next day. The time it takes the water to go through the sand depends upon how closely the sand is packed, (there is a personal equation) and it also depends upon the temperature. The higher the temperature of the water the quicker it will go through. So the temperature of the water was taken each time and a correction applied. The size of this correction is rather surprising at first. A sand will pass twice as much water, other conditions being equal, at summer heat, 76°, as it will at the winter temperature of 32°, so the importance of applying the correction is very apparent.

The sand has to be under-drained by gravel. You understand the general scheme of the filter.* It is comparatively level, in some places there is something of a slope, but there is a broad bed of sand which is supported by gravel. The water passes down through the sand, and then the gravel takes the water rapidly from the point where it comes through to the under-drains. We have gotten out something like a thousand yards of gravel of different sizes to support this sand. The gravel immediately under the sand is comparatively fine, so fine that the sand cannot work into its pores, and then grad-

*In Prof. Sedgwick's paper this volume, page 103, details are given in regard to many European filters.

ually grows coarser to the under-drains. To get out gravel of the different sizes we started with hand screening, but that was very expensive, shoveling it over by hand each time. And as the material was coming out of the side of a bank some 40 feet high and all had to come down, it occurred to me that we might put screens in position and make the material screen itself in coming down. And so we built, with the help of Mr. Salisbury, a screening appliance of which I have some photographs. The mixed material running down the chute is sent over a screen with inch and a half meshes and down into a bin; all sand going through the screen is sent over another screen three-quarters of an inch, then three-eighths and three-sixteenths, all the sand coming out at the bottom and the different sizes of gravel piling themselves up in bins ready to be carted off. In that way we reduced the cost of screening the gravel to probably not more than half what it had been by hand screening.

The sands in these bottles (exhibiting specimens) are the standard sizes, having the frictional resistance selected by Mr. Mills. One of them is a little coarser than the other; they are marked "50" and "70," those figures representing the relative amounts of water which the sands will pass under comparable conditions. And in this bottle I have put another sand which is more mixed. It has the same co-efficient of friction as this sand. They are each of them marked "50," but one of them contains more coarse particles than the other. This sand the men who have been taking out the sand would invariably consider a great deal coarser than this. We could not get them to look at the sands in such a way as to determine the sizes from their appearance. These two sands are actually of the same effective size for filtration, but the apparent sizes are quite different. (Applause.)

LIGHT FOR NIGHT WORK.

BY

EDWIN P. GARDNER, SUPT., NORWICH, CONN.

When one has outside work to do at night, the comfort and efficiency of the men, the measure of success attending his labor and the cost of the job, depend largely upon the amount of artificial light he is able to throw upon the work and its surroundings. The electric light answers the purpose admirably when it can be obtained, but it is not always available.

The use of kerosene lanterns, black lamps or torches is very unsatisfactory. A light for this purpose should be portable, reliable, efficient, easily managed, economical and durable.

In conversing with our members I find there are some who do not know

that such a light has been invented and can be easily obtained. This is the excuse for this paper.

During the past eighteen months I have used the Wells light and have found it to answer the above requirements admirably.

It consists of a galvanized steel tank, about 18 by 24 inches, into the top of which is inserted and fastened an air pump. From the top rises a 1-inch stand pipe, attached to the base of which is a pressure gauge and a peculiarly constructed valve and strainer. Into the top of this stand pipe is inserted a burner, formed principally by a series of tubes arranged around a hollow square and terminating at the back end in a jet about 1-64 of an inch in diameter, directly in front of which is a hollow iron cone. Immediately under the burner and fastened to it is an iron dish or cup.

Its operation is as follows: First fill the tank about three-fourths full with kerosene oil and by means of the air pump, force air into the tank until the gauge shows a pressure of 20 to 25 pounds. Then fill the dish or cup, under the burner, with kerosene oil and place over it the temporary sheet iron chimney or cover. Light the oil in the cup and the flame will heat the tubes. When sufficiently heated open the valve at base of stand pipe and the pressure in the tank will force oil up said pipe and through the tubes, where the heat will change it into gas, which will escape through the jet and hollow cone and be ignited in the hollow square formed by the tubes, producing a flame from 24 to 30 inches long, giving a pure white light. The flame in passing through the hollow square keeps the tubes hot, producing a continuous stream of gas, so long as there is oil and pressure in the tank. By means of the air pump the pressure may be kept up and the tank filled with oil while the light is burning.

The consumption of oil is about one gallon per hour. I have used it principally while repairing breaks in cement water pipe. It illuminates a large area, so that one can readily find the small tools needed and can watch the banks of the ditch, to note any indications of caving. Ordinary print can easily be read when standing 100 feet from the burner.

I have used it all night with the thermometer at 6° and again at 75°; when the air was still and when the wind was blowing 25 miles per hour; in clear weather and in a severe rain storm.

By placing a short section of oil hose between the stand pipe and burner, the latter may be lowered into the ditch, raised up on a platform or hung up on a pole. In this way it may be used for melting lead or heating as well as lighting.

I have also used it for melting out lead joints in iron pipe. By means of the oil hose referred to above, the flame can be directed against the lead and with the aid of a blow pipe, connected to a stop in the top of the tank with rubber tubing, I could easily melt the lead. Within ten minutes after the lead was melted out I could handle the pipe with bare hands. The pipe was left in good condition to use again, for the coating was not destroyed as it is when the lead is melted out by fire.

In this work, however, I met with two difficulties. First. To keep up the pressure in the tank with the air pump, for both the burner and blow pipe.

I think this can be overcome by having two air pumps in the tank.

Second. The tendency of the blow pipe to disintegrate and fill up the orifice, in consequence of the intense heat to which it was subjected.

Perhaps this can be overcome by using a platinum or lava tip. Further experiments are needed in this direction before definite results can be given.

DISCUSSION.

Mr Nevons. What is the cost of the light?

Mr. Gardner. It costs $100.

Mr. Sherman. I would say we have been using five of these lights in our foundry for some two months, and all the gentleman claims for it is true, with the exception, that instead of a consumption of one gallon per hour, we have found it about a gallon and a quarter per hour of oil which costs about 5 cents a gallon.

Mr. Gardner. Some nights we have used a gallon and a quarter. It depends upon the length of the flame produced.

Mr. Gould. I should like to inquire how large a pipe you have burned out with it?

Mr. Gardner. The only time I have put it into practical operation in the ditch was on a 10-inch joint. One night I had a 10-inch joint to melt out for the purpose of extending the pipe, and I think I used just an hour on the job, but a considerable part of that time was taken up in clearing the orifice in the blow pipe with a pin, we had to keep stopping and cleaning it out, in consequence of its being an iron blow pipe. And then as I was anxious that the experiment should be a success, because there were a hundred or more people looking on, I spent more time than was necessary. From the fact that my eyes were not protected with colored glasses as they should have been, I found I had not only melted out the lead but had burned out all the gasket, which, of course, was not necessary. I expected to find a little lead at the inside of the joint, but it was completely gone, gasket and all, which shows that I kept the flame on longer than was necessary to remove the lead. After the first few moments of its use I became light-blinded, so I could not distinguish readily when I had finished melting the lead in any one particular spot.

Mr. Gould. I have tried to burn out a 40-inch joint, but found life was too short for the work. I used up one forenoon and got about six inches.

Mr. Gardner. I found no trouble with the 10-inch joint. I couldn't very well have melted it out by fire, because there was a 4-inch gas pipe running diagonally over the joint, and I wouldn't have dared to have built a fire. But with this light I succeeded in melting it out nicely.

EXPERIENCE WITH CEMENT LINED PIPES.

BY

JOHN C. HASKELL, SUPERINTENDENT, LYNN, MASS.

Although it may seem that any reference to cement lined pipes is unnecessary and that no city or town would use these pipes in the construction of new works, still when we are requested to contribute experience papers to this association some of the superintendents in the cities where cement lined pipes are used may have sufficient experience to furnish material for several papers.

The experience of the city of Lynn with bursts in this kind of pipe is what I will talk about today.

From the first introduction of water in 1871 up to 1876, 48 miles of this pipe were laid. From that time additions were made yearly until 1887, when we had 82 miles of cement lined pipe; since that time no new work has been added. We can give an experience derived from 48 miles of pipe in use since 1876 together with additions averaging about 3 miles per year for 11 years, since which time 5 miles have been replaced with cast iron.

Previous to 1876 we have no record of the bursts, since then they have occurred from year to year in the following number:

1876, 95; 1877, 79; 1878, 79; 1879, 102; 1880, 121; 1881, 103; 1882, 75; 1883, 92; 1884, 84; 1885, 105; 1886, 86; 1887, 110; 1888, 79; 1889, 106; 1890, 136; 1891, 136; 1892, 133.

These were in pipes from 4-in. to 16-in. in size.

This number of bursts means a varied experience, in some cases a heavy damage to property amounting, in one instance, to over $10,000, in others to a serious interference to business by depriving boilers of water and thus shutting down the factories run by power. In all cases an expense for repairs and a risk of fire occurring in the district deprived of water when the loss of only one hydrant might cause much delay to the firemen. The bursts give no warning. In one instance occurring while a man was standing over the pipe which had been uncovered for a service connection. Sometimes several occur in different sections of the city at nearly the same time and during the past year two were reported at once situated over two miles apart. The greatest number of sections I have had deprived of water at one time is six.

During the summer the water generally comes to the surface directly over the leak and runs down the gutters thus showing the location of the leak. In the winter with several feet of frost in the ground the water follows a course where it meets the least resistance. If a sewer connection has been made at any dwelling in that vicinity it follows the line of the

refilled trench and makes its first appearance in the cellar of the building and usually with sufficient noise to wake up the sleepers. On these occasions the superintendent has an opportunity to exercise his tact in adjusting damages which I find can be done satisfactorily at the time. In almost all instances, a large proportion of the bursts occur in the night at the time when our pressure is at its height. During the past year an additional 20-in. pipe for fire purposes was laid, connecting our present reservoir with the centre of the city. On the completion of the work the gate was opened raising the pressure on the recording gauge from 60 to 62 lbs

While it would seem that such a slight increase in pressure would not cause any perceptible increase in the number of bursts, we had 6 that night and within five days a total of 19.

No farther use has been made of this main but in case of a large conflagration it is ready for use. To reduce the risk of damage as far as possible and to repair all bursts without delay we always keep, through the day, a man in the stable connected with the office of the Water Department who is never absent except during the time taken to shut off a burst and return. In the night two men are kept in readiness, a wagon provided with lighted lanterns, a book containing a diagram of each section and all gates, and the necessary tools to be used. As soon as a burst is reported, no time is lost until the gates are closed. The time when the burst is reported, when the section is shut off, and when the water is turned on is recorded. In many cases the section is closed within ten minutes after receiving the report, the burst repaired and water turned on within three hours. We have had three bursts during one night in the business section of the city and all repaired and water on before 6 o'clock in the morning.

One morning during the past year the Edson recording gauge indicated a loss of pressure of about seven pounds occuring the night before just after 10. As no burst had been reported and nine hours had passed since it occurred it was evident that it was situated at some point where the water could escape without being observed. As the brooks furnish the best channels for the escape of water unperceived, men were sent to examine the culverts of all streets to see if there was any increase in the flow below the culverts and to all the sewers.

As we have 109 miles of pipe, 77 of which is cement lined on which to find the burst, I divided it into nearly equal sections by closing fourteen gates, the pressure showed which section contained the leak. This division was continued until the section included one street, 1750 feet in length with three cross streets, and closing the gate on one of these cross streets the flow of water through the pipe showed the leak to be on that street and as there was an abandoned culvert running through the long street under which the pipe from the cross street ran, we went there and found the burst. On excavation it was found that the pipe was broken entirely off, one end lying below the other. It was probably broken by the covering stone over the culvert falling on the pipe which must have been undermined by the flow of water. At this time there was three feet of frost in the ground which prevented the water coming to the surface.

The burst was found in a 4-in. pipe, seven feet from its connection with a 6-in. pipe and 500 feet from a 12-in. About four hours was lost in finding it and three hours for repairs before the water was turned on.

The intention of the Water Board is to replace the cement lined pipe with cast iron in all business streets and in residential streets whenever the cost for repairs nearly approaches the interest on the cost of relaying.

DISCUSSION.

MR. JONES. The gentleman speaks of having had so many bursts. I would like to ask him how many *leaks* he had.

MR. HASKELL. In our 16-in. pipe we had quite a number of what we called simply leaks, but if they were not repaired right off, almost as soon as they showed, they would have resulted in a burst. The only point where I would draw a line would be where the leak is due, perhaps, to a spread of the iron, and not a hole through the pipe.

MR. S. J. WINSLOW. Was it what is called the old-fashioned make of cement pipe?

MR. HASKELL. The first 48 miles of it was what might be called the very best contract work. But perhaps our pipe stood as well as it does in any city. I should think it represented really a better class of work than is done in many cities.

MR. S. J. WINSLOW. I know something about a pipe that is manufactured entirely of cement, with two jackets of sheet iron. I have had some experience with that, and I would like to know if you have had any acquaintance with it.

MR. HASKELL. We have had a piece of pipe we laid ourselves that probably came nearer such a pipe and that was laid with almost clear cement. Our old pipe was laid, I should judge, with certainly three parts of sand to one of cement, and wasn't properly mixed at that.

MR. S. J. WINSLOW. That accounts for your trouble, probably.

MR. HASKELL. That is the trouble with it *largely*, but bursts mostly occur where the cement has been knocked off the iron. Where a sewer trench runs across a water main, the workmen are very apt to knock some of the cement off the pipe. Then again the excavation very often has a tendency to make a depression, the whole surface of the ground settles a little at that point, and that injures a cement pipe. And there are various causes that affect a cement lined pipe in a thickly settled city that do not apply to it in the outskirts, where the pipe is undisturbed. We have on our line that runs to the reservoir a 20-in. pipe, laid at the same time that this other pipe was laid and there has never been a burst on it or a leak on it that we have had to repair.

MR. S. J. WINSLOW. Who laid that?

MR. HASKELL. That was laid by the same party, but it extends through a territory where it has never been disturbed in any possible way.

MR. S. J. WINSLOW. If I understand you, your judgment would be if that kind of pipe was laid as it should be, with proper care, it would be all right.

MR. HASKELL. I have had a good deal of experience with cement, and I have never felt any great confidence in mixing large quantities of it as we would have to in a line of cement pipe, that it would be possible to do the work and not have portions of the pipe which was covered with cement which would not be as strong as other portions of it I should not feel much confidence in it even with the greatest care.

MR. S. J. WINSLOW. I know and fully understand that the standard pipe in this country, and I presume in all other countries, is of iron or it may be coming to be of steel. I will say that with an experience of eight years our cement pipe has proved highly satisfactory thus far. It is made of pure cement, and as far as our experience has gone we wouldn't want to change it for any pipe we have ever heard ot or seen.

MR. DARLING. I think after you have had an experience with that cement lined pipe as long as my friend has you may reverse your opinion. It was our misfortune at Pawtucket that in the original 24 miles of pipe that was laid we had a contractor who put in very short lead. And we have had, on the original 24 miles of pipe, a great many leaks as high sometimes as 200 leaks in a year, caused simply by the lead blowing out. Since that time I have superintended the laying of about 80 miles of pipe, and I don't know of 10 leaks on the 80 miles.

If you lay iron pipe and lay it properly, if you put in the lead as it ought to be, and give plenty of it, I never saw yet in my experience any trouble with it.

Now, at the price of iron pipe today, I should consider it foolish for any town, city or hamlet to undertake to put in what you call cement pipe. I believe in ten or fifteen years from now, he will get the same experience with this cement pipe that these gentlemen say they get at the present time; because I think and believe they tried to do, and did do, perhaps, full as good work in those days as they are doing today.

MR. S. J. WINSLOW. I want to get at the facts. I know all about that old-fashioned cement pipe. I know all about how the iron pipe worked at Amesbury. If we are to have trouble, in 15 or 20 years I want to be prepared for it.

MR. DARLING. I believe it would be for your best interest to put iron pipe into the ground instead of putting in cement pipe.

MR. JONES. I would like to ask one question of Mr. Haskell. (My experience has been altogether with iron pipe.) As he has had experience in both iron pipe and cement pipe, if there were two water works to be constructed of equal size which of the two he would prefer to take, one being cement pipe entire and the other one iron pipe entire. I would like to ask which he would select to take charge of, everything else being equal.

MR. HASKELL. I should take the iron pipe.

THE PRESIDENT. We would like to hear from Mr. Walker.

MR. WALKER. I could talk all night about cement pipe, getting up nights and tumbling out of bed at all hours, if it would do the gentleman from Pittsfield any good, but it wouldn't, because his is a different kind of pipe. Mine is the old-fashioned pipe.

MR. S. J. WINSLOW. It isn't like ours, is it?

MR. WALKER. No sir; mine will burst every 15 minutes. (Laughter.) About 18 years ago I was elected superintendent of the Manchester works. They then had about 28 miles of cement pipe, and I was told there wouldn't be much to do, that I would only have to look around once in a while and sign bills, and everything would take care of itself, so I thought I had better take the work. But I soon found out, and I say it today in all seriousness that, considering the responsibslity they take, superintendents of water works are the poorest paid men on earth. A manufacturing company which represents the same amount of money pays its superintendent three times as much as the men are paid who have charge of water works. The trouble is that everybody in the city thinks he can run the water works better than the superintendent. If you fail in anything you try to do, they will tell you they knew it would fail. And if you start something which turns out all right, up comes somebody who says, "Well, I should have thought you would have thought of that before." (Laughter.)

FIRE PROTECTION FOR MANUFACTURING ESTABLISHMENTS.

DISCUSSION.

MR WALKER. I would like to inquire how large a pipe should be put into a mill or factory for sprinklers for fire protection? We will call the mill 200 feet long, 50 feet wide and three stories high; pressure on the mains 40 to 60 lbs. Is it customary to charge anything for putting in the pipe or for the use of the water so supplied? I ask these questions for I have tried to keep the size as small as possible because in case of a fire they break off sometimes. Now in the city of Manchester, say on Elm street, new blocks are being erected three to five stories high and not more than 50 feet front, we have on this street 60 lbs. pressure. If a 4-in. branch is put in to each place on both sides, they would be 25 feet apart.

We will suppose that we have a big fire on this street and four of these supply pipes break off and you could not get at the gates, it would take away the pressure to such an extent that serious damage would result to adjoining property. I think that owners of the property should pay for the expense of putting in the pipe and a rental besides. A city or private corporation should have to pay for increased fire protection whether for hydrants or automatic sprinklers.

MR. NEVONS. In Cambridge we put in any size they want and make them pay the whole bill. The largest we have put in so far is 8 inches.

MR. WALKER. Do they pay anything for the benefit they get from it?

MR. NEVONS. No. We seal it up, and in case of fire they have a right to break the seal, and they have to notify us and as soon as the fire is over we reseal the pipe.

MR. WALKER. How many pounds pressure have you?

MR. NEVONS. We have ordinarily about 30 pounds.

THE PRESIDENT. Perhaps Mr. Freeman can give an opinion on this subject.

MR. FREEMAN. I have had a very pleasant experience with a good many of you gentlemen in requesting pipes to be put in, and I think that all through the New England states we may say the custom is to put in pipes such as Mr. Nevons has described, and generally the mill pays the whole expense of putting it in. In places where the municipality owns the water works it is very rare indeed that any charge is made for the use of the water. It is considered that the factory is enough benefit to the town, that its protection is of enough interest to the citizens of the town, and that the taxes which they pay amount to enough to entitle them to receive the protection which such a pipe would give, and it is very rare that any charge in the way of a rental for fire service is made. Where the water company is a private corporation the practice varies. In some cases, in a great many cases, no charge is made except for water actually drawn. In other cases there is only a nominal rental, and in some cases there is quite a high rental charged. But the general prac-

tice, I think I may say, as far as my experience has extended, is that in a majority of cases the mill pays the bill for all expenditures of labor and material, but does not as a rule pay a rent.

Now, as to the size of the pipe which is permissable, that like everything else, depends a great deal on the surrounding conditions. In many cases a 12 inch pipe into a yard is not objectionable in any way, because there is ample room to provide a stop gate and arrange it so that it can be shut off in case of any breakage. There are other cases, of course, as in the streets of Boston, where anything larger than a 4 inch pipe could not be tolerated with safety. It is a matter which depends entirely upon the surrounding conditions. I think ordinarily by the exercise of a little skill, ingenuity, and foresight, in planning the entrance for the pipe, it can be placed at a point which is free enough from danger so that there is no extra hazard run by permitting the connection, that is, by locating the gate at a point where it might be reached under almost any circumstances.

Mr. Stacy. Mr. President, this question is one that we have had to consider in the city of Marlboro, where we have some of the largest shoe factories there are in New England. Our pressure there varies from 35 pounds to 105, and (I believe Mr. Freeman doesn't cover that district) they generally all want the same size pipe, no matter what the pressure is nor what the size of the pipe is with which they are to connect. Our practice has been to make sprinkler connections under the same conditions that we put in a service pipe, we carry it to the street line, and the rest of it is done at their expense, that is for the first pipe. For any additional pipe they have to pay the whole expense. The insurance companies by a reduction of rates have induced the factories to put in two services connecting with different sections of the main pipe with check valves so a break in one section between two gates would not deprive a shop of water for the fire sprinklers, and the manufacturers have always paid the entire expense for the second connection. As Mr. Freeman has suggested, the way we look on the question in the city of Marlboro is that the factories are the life of the city, and we should protect them to a certain extent. At the same time we consider that they should pay a certain amount of money towards the revenue of the city. There has been only one instance in which we have had to make any trouble, and that was where sprinklers were connected and the help had to go across the street to get water to drink; and we thought that possibly they were using some of the water from the sprinkler connection for their boilers, and we made them tap the pipe and put on a meter, and now they are using our water altogether. The water is free for fire protection, but no connection is allowed with the sprinkler connection except by a meter. The first connection is free to the street line on the same conditions that a service would be put in, and they pay the entire additional expense.

Mr. Fuller. I am a little interested in this matter. It has seemed to me, and the question came up with us in the town of Wellesley, where we have very little manufacturing, that on account of the large expenditure which had been made in order to give fire protection the mills should be willing to pay a small amount for that protection. And so for the few private hydrants we have in mill yards we have made a charge of $10, and also a

charge for sprinklers, I don't remember what, but not very much. It is true that towns ought to encourage manufacturing, but at the same time a great many of our water works have cost a great deal more money on account of being built to provide fire protection than they would if they were simply for domestic service, and I hardly see why the mill and factories in view of the reduction in insurance which they get, and the protection which they enjoy, should not be willing to pay something towards this increased cost of the works.

MR. RICHARDS. During the Lynn fire, as appears by Mr. Haskell's paper,* in spite of the greatest precautions, two 4 inch service pipes were broken by falling walls. They discharged for 20 hours or more, wasting at least one-half the water consumed, and greatly reducing the pressure. Yet the insurance companies are constantly demanding 4 inch and 6 inch service pipes to supply fire sprinklers and stand pipes. Would it not be well to consider a remedy for this?

In the narrow streets often found in New England cities, placing gates at the opposite curb would but slightly decrease the liability of being covered by falling walls, and it would seem that the "Indicator Post Valve," with stem above the surface, is more likely to be damaged than the underground gate.

It would appear that the insurance companies are willing to jeopardize the surrounding property to protect their particular risk.

MR. FREEMAN. As to the case quoted from Mr. Haskell's paper where two 4-in. service pipes were broken by falling walls, a kind of accident for which Mr. Richards very properly suggests that a remedy should be looked for, I would say that had these pipes been guarded by shut-off valves properly located in the manner suggested in my paper on this subject† this loss of water need not have happened.

We have by no means obtained our ideal in the older mill yards, but we are steadily progressing toward it.

For several years past special care has been taken in our factory yards to provide an easily accessible and very conspicuous "outside shut off" for every large pipe leading inside the mill.

Several hundred of the "Indicator Valve Posts" illustrated in my paper, have been put in for this purpose in factory yards during the past two years and in a few instances it has happened that when I have urged a water works superintendent to put in something of this kind at the curb stone line or at the fence line, or even at the curb stone line across the street, (running over and placing gate on opposite side of street and coming back with a return bend in order to get the said indicator gate post beyond the reach of falling walls,) he has sometimes told me that he guessed the old style under-ground gate with all the possibilities of the gate box being filled by gravel and ice, or the cover being frozen down or hidden, or where it could not be operated without half an hour's vigorous work, "would do."

The remedy for preventing these wastes of water is plain, all that is needed is for more superintendents to vigorously apply the remedy.

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*Vol. VII. p. 47.
†Vol. VII, p. 57.

As to the "Indicator Gate Post" being more susceptible to damage by a falling wall than an underground gate I would say that the gate itself is precisely the same in either case. The "Indicator Post" is merely a long stem with a tell-tale attached and an outer iron case to protect the whole. This stem is connected to the regular gate stem in such a loose or flexible way that no injurious blow would probably ever be transmitted to the main gate by its means.

In reply to Mr. Richards' suggestion that in urging these large pipes for sprinkler supplies off the city mains the underwriters—in so protecting one risk jeopardize its neighbors—it is to be said that experience, as well as reason, proves that whatever is done to make one building safe, adds also to the safety of its neighbors.

In the great Boston fire of a few days ago, the sprinklers in the Brown & Durrell building made all the surrounding property safer, and indeed, it is claimed by excellent judges, that had it not been for the retarding effect of these sprinklers the fire would have cut a clean swath through to Washington street.

Furthermore, I am informed on most excellent authority that Brown & Durrell had, a few months ago, begged their neighbors, Partridge & Co., to install sprinklers as they had done, that the whole neighborhood might be safer. Had they heeded this, the Brown & Durrell and Partridge & Co's. buildings would undoubtedly be standing today.

New England Water Works Association Membership Roll.

March 10th, 1893.

NOTE.—The secretary requests to be advised of existing errors or changes of address from that which appears in the following list.

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The Engineering Record, 277 Pearl street, New York city.

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Fire and Water, Box 1117, 14 Cortlandt street, New York city.

ASSOCIATE MEMBERS.

Adee, Fred & Co.
"Plumbers' Supplies," 90 Beekman street, New York city.

Ashton Valve Co.
"Water Relief Valves," 271 Franklin street, Boston, Mass.

Betton, James M.
Agent H. R. Worthington, 70 Kilby street, Boston, Mass.

Blake, George F. Mfg. Co.
"Pumping Engines," 95 and 97 Liberty street, New York city.

Boston Lead Mfg. Co.
162 Congress street, Boston, Mass.

Brandt, Randolph
"Selden Patent Packing," 38 Cortlandt street, New York city.

Brewster, H. M. (E. Stebbins Mfg. Co.)
"Brass Goods," Brightwood P. O., Springfield, Mass.

Chadwick Lead Works
176 to 184 High street, Boston, Mass.

Chapman Valve Mfg. Co.
"Valves and Hydrants," Indian Orchard, Mass.

Coffin Valve Co.
"Valves and Hydrants," Neponset, Boston, Mass.

Crawford, M. H.
The Radford Pipe and Foundry Co. of Cincinnati, O. "Cast iron pipe." Address, 523 Exchange Building, Boston, Mass.

Crosby Steam Gage and Valve Co.
"Gages, Valves, etc.," George H. Eager, Treasurer, 93 Oliver street, Boston, Mass.

Curtis Regulator Co.
"Pressure Regulators," 29 to 33 Haverhill street, Boston, Mass.

Davidson, M. T.
"Steam Pumps," 43 and 53 Keap street, Brooklyn, N. Y.

Deane Steam Pump Co.
"Steam Pumps," Holyoke, Mass.

Drummond, M. J.
"Cast Iron Pipe," 192 Broadway, Corbin Building, New York city.

Dunne, George C.
Manager Portland Stoneware Co., 42 Oliver street, Boston, Mass.

Edson, Jarvis B.
"Pressure Recording Gauges," 87 Liberty street, New York city.

Eglee, Charles H.
Contractor, Flushing, N. Y.

Fairbanks Co., The
"Valves," 83 Milk street, Boston, Mass.

Frost & Adams
"Architects' Supplies," 37 Cornhill, Boston, Mass.

Gallison, William H.
"Engineers' Supplies, Pipe, etc.," 36 Oliver street, Boston, Mass.

Gilchrist & Taylor
"Pipe and Fittings," 106 High, corner Congress street, Boston, Mass.

Giles, Jason
Chapman Valve Mfg. Co., "Valves and Hydrants," Indian Orchard, Mass.

Hattersley, John
Agent Common Sense Metallic Packing Mfg. Co., 393 Pearl street, New York city.

Hersey Manufacturing Co.
"Meters," South Boston, Mass.

Holly Manufacturing Co.
"Pumping Machinery, Hydrants, Valves," Lockport, N. Y.

Holyoke Hydrant and Iron Works
"Hydrants," Holyoke, Mass.

Hydraulic Construction Co., The
"Well Plants," Wm D'H. Washington, Manager, Room 20, 145 Broadway, New York city.

Jackson & Woodin Mfg. Co.
"Cast Iron Pipe," Berwick, Penn.

Jenkins Bros.
"Valves and Packing," 105 Milk street, Boston, Mass.

Jenks, Henry F.
"Drinking Fountains," Pawtucket, R. I.

Johns, H. W. Manfg. Co., Eastern Branch
"Asbestos Packing," 119 Federal street, Boston, Mass.

King & Goddard
"Pipe and Fittings," 64 and 66 Pearl street, Boston, Mass.

Ludlow Valve Mfg. Co.
"Valves and Hydrants," Troy, N. Y.

Lynch, John E.
Proprietor "E. Hodge & Co., Stand Pipes," East Boston, Mass.

Meter Register Co.
52 Illinois street, Chicago, Ill.

Michigan Brass and Iron Works
"Valves, Hydrants, and Brass Goods," L. McHugh, Agent, Detroit, Mich.

Millar, Charles & Son
Selling Agents, Utica Pipe Foundry Co., Utica, N. Y.

Moore, G. H.
"Water Filters," Norwich, Conn.

Morgan, A. W. Mfg. Co.
"Gate and Service Boxes," 52 Niagara street, Buffalo, N. Y.

Morison, Samuel L.
"The Morison-Allen Co., Water Purifiers," 145 Broadway, New York city.

National Meter Co.
"Meters," 287 Broadway, New York city.

National Tube Works Co.
"Pipe and Fittings," McKeesport, Pa. Address P. W. French, Secretary, 70 Federal street, Boston, Mass.

Nye, Walter B.
"Warren Filter," 220 Devonshire street, Boston, Mass.

Partridge, W. T.
45 Broadway, New York city.

Paul, George K. & Co.
"Pipe and Fittings," 98 Milk street, Boston, Mass.

Peet Valve Co.
"Valves, "163 Albany street, Boston, Mass.

Perrin, Seamans & Co.
"Construction Tools and Supplies," 57 Oliver street, Boston, Mass.

Ranton, William J.
Superintendent Ranton Boiler Co., 1204 Spring street, Syracuse, N. Y.

Reed, Wilmer
Agent McNeal Pipe and Foundry Co., Burlington, N. J.

Rensselaer Mfg. Co.
"Water Valves," Troy, N. Y.

Roberts, C. E.
Hartford Steam Boiler Inspection and Insurance Co., 125 Milk street, Telephone Building, Boston, Mass.

Robertson, R. A.
Treasurer Builders Iron Foundry, P. O. Box 218, Providence, R. I.

Ross, George
"Valves," Troy, N. Y.

Ryder, N. F.
"Varnish," Middleboro, Mass.

Sampson, George H.
"Powder," 147 Pearl street, Boston, Mass.

Smith, Anthony P.
"Tapping Machines," 748 Broad street, Newark, N. J.

Smith & Anthony Stove Co.
Water Works, Steam and Gas Supplies, 52 Union street, Boston, Mass.

Standard Thermometer Co.
"Electric Indicators," Peabody, Mass.

Sumner & Goodwin
"Pipe and Fittings," 21 Oliver street, Boston, Mass.

Talcott, C. W.
"Contractor," Woonsocket, R. I.

Taunton Locomotive Manufacturing Co.
Castings, Boilers, Forge Works, Taunton, Mass.

Thomson Meter Co.
"Meters," 83 Washington street, Brooklyn, N. Y.

Union Water Meter Co.
"Meters," 31 Hermon street, Worcester, Mass.

Waldo Bros.
"Contractors' Supplies," 88 Water street, Boston, Mass.

Walworth Mfg. Co.
"Pipe, Brass Work, Service Boxes, etc.," 16 Oliver street, Boston, Mass.

Wolfendale, Wm.
Agent Plumbers' Supplies, 76 Second street, Fall River, Mass.

Wood, R. D. & Co.
"Cast Iron Pipe," 400 Chestnut street, Philadelphia, Penn.

Woodman Co., The George
"Pipe and Fittings," 41 Pearl street, Boston, Mass., P. O. Box 3653.

Worthington, H. R.
"Steam Pumps," 86 Liberty street, New York city.

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ANNOUNCEMENT.

An index of the Journal and proceedings of the Association from its organization to June 1st, 1893, is now being prepared by Henry N. Ogden, C.E., of Chicago, Ill., and will be published at a later date.—JUNIOR EDITOR.

ERRATA.

On page 208, first line, for "total strength" read "total *strain*."